Economic Benefits

arising from the

Canadian Nuclear Industry

March, 1982

ECONOMIC BENEFITS ARISING FROM THE CANADIAN NUCLEAR INDUSTRY

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Canadian Nuclear Association
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Toronto, Ontario, M5G 1P7

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FOREWORD

In September 1978 Leonard & Partners Ltd. submitted the report "Economic Impact of Nuclear Energy Industry in Canada" to the Board of Directors of the Canadian Nuclear Association. In 1978, 1979 and 1980 the Economic Development Committee (EDC) of the Association conducted statistical surveys of the CNA membership and submitted reports of these surveys to the CNA Board. Unfortunately not all companies responded to each survey and some of the information which was provided did not stand critical examination. As a result the reports were not made public. It was intended that the annual surveys would complement the report of Leonard and Partners Ltd.

It is important that the CNA have current economic data on Canada's nuclear industry available for public discussion. As a result during 1980 the EDC examined several alternatives which could be used in place of the statistical survey. It was decided to develop future scenarios for the various segments of the nuclear industry based on the best available data and judgements. This work has been completed and the following reports have been submitted to the Board of Directors of the Association.

- Canadian Uranium Industry 1981-1990
- Economic Benefits Arising from the Design, Manufacture and Construction of CANDU Electric Generating Stations
  (This is referred to as "Reactor Study" several places in this document)
- Overview of Nuclear Industry in Canada touching on
  - . Research and Development
  - . Nuclear Fuel Manufacturing
  - . Radionuclides for Industry and Medicine
  - . Operation and Maintenance of CANDU Electric Generating Stations and Heavy Water Plants
  - . Regulatory Agencies
- Employment and Economic Activity in the Canadian Nuclear Industry

This document is an assembly of the reports and is made up as follows:

- Synopses of
  - . "Canadian Uranium Industry 1981-1990".
  - . "Economic Benefits Arising from the Design, Manufacture and Construction of CANDU Electric Generating Stations".
  - . "Overview of the Nuclear Industry".
- -Recommendations to the Board of Directors of the CNA which were included in the "Reactor Study"
- -The Reports:
  - . Employment and Economic Activity in the Canadian Nuclear Industry
  - . Canadian Uranium Industry 1981-1990
  - . Economic Benefits Arising from the Design, Manufacture and Construction of CANDU Electric Generating Stations
  - . Overview of the Remainder of the Nuclear Industry

The committee wishes to thank those persons who provided information for these reports, those persons who commented on the earlier drafts, Messrs. H.B. Merlin and R.M. Williams of Energy, Mines and Resources, Canada for developing the scenarios for the report on the Canadian Uranium Industry, and Mr. H.B. Leng and his associates at Ontario Hydro for providing the facilities and effort to assimilate and analyze the economic and employment impact of the scenarios developed for "Reactor Study".

SYNOPSES

CANADIAN URANIUM INDUSTRY 1981-1990

Recent statistical information on Canadian producing operations in mining, milling and refining shows that:

There were seven uranium processing plants in 1979 with an eighth, Cluff Mining, coming into operation in 1980. Production was 6817 tonnes U in 1979 and 7145 tonnes U in 1980. The workforce was 5721 in 1979 and 6068 in 1980.

Eldorado Nuclear Limited produced 5800 tonnes U of UF_6 and UO_2 in 1979 and 5200 tonnes in 1980. Eldorado's employment at other than the mine and mill, was 883 in 1979 and 892 in 1980.

Four scenarios for the uranium mining and milling industry for the period 1981 to 1990 were developed by Messrs H.B. Merlin and R.M. Williams of

Energy, Mines and Resources Canada. These covered the range from very pessimistic to optimistic.

Scenarios A and B which are pessimistic see a planned investment of 500 million dollars for the early 1980's dropping to less than 100 million dollars during the period 1985 - 1990. Direct Employment would stay near present levels, production capability would decrease 5 to 15% and product value would decrease 25 to 30% from present levels. Scenario C, where prices stabilize and demand begins to rise, would see high capital investment to 1985 and then very little additional investment. Direct employment will grow 15 or 20%, production capability will grow 50 or 60% and the product value would grow 60 or 70%. In Scenario D, the optimistic scenario, capital investment would be about 2 billion dollars to 1985 and would be 800 million dollars from 1985 to 1990. Direct employment would grow 50 to 70% over the period. Production capability would double by 1985 and grow slightly during the latter part of the decade. Product value would grow 125% by 1985 and an additional 135% of 1980 levels by 1990.

Use of uranium in Canada is directly related to operating nuclear generating stations. In 1980 they used 1100 tonnes U. By 1990 operating stations and those under construction will use 2000 tonnes U. As a result the uranium industry must have exports to remain viable. Three scenarios developed for the "Reactor Study" report would see uranium usage in Canada grow to 4700 tonnes U for the high growth scenario, 4100 tonnes U for the medium growth and 3000 tonnes U for the low growth scenario by the year 2000.

Exploration expenditure grew from 71.7 million dollars in 1977 to 128.3 million dollars in 1980, with 60% occurring in Saskatchewan in 1980. Because of low market demand and significant discoveries it is expected that annual exploration expenditures will vary between 26 and 45 millions in Saskatchewan during the next decade.

ECONOMIC BENEFITS ARISING FROM THE DESIGN, MANUFACTURE AND CONSTRUCTION OF CANDU ELECTRIC GENERATING STATIONS

Three scenarios have been developed for "In Service" CANDU electric generating stations at home and abroad. The potential economic benefits

to the year 2000 arising from the construction of these CANDU stations is shown. Conclusions are drawn concerning the present situation in the industry and the possible effect of the scenarios. Recommendations arising out of the conclusions are made.

SCENARIOS

The scenarios are High Growth, Medium Growth and Low Growth. Present Commitments are also included to provide a base line against which the scenarios can be compared. The CANDU electric generating units in Present Commitments and those forecast in the three scenarios are shown on pages 29, 31 and 33.

The scenarios are based on the following:

- Ontario: The High Growth Scenario visualizes the December 1980 peak of 16,808 MWe growing at 3.5% per year to 2000. The Medium and Low Growth Scenarios are somewhat below this.
- Quebec: The High Growth Scenario sees the Quebec government placing less dependence on the long distance transmission of hydro electric power and committing some CANDU stations closer to the centres of electricity demand. The Medium Growth Scenario sees the same pattern with a smaller shift to CANDU. The Low Growth Scenario sees the continuance of full dependence on the long distance transmission of hydro electric power.
- Nova Scotia and New Brunswick: The High Growth Scenario sees the displacement of coal and oil by nuclear and "pre-building" for the export of electricity. The Medium Growth Scenario is similar except with less growth. The Low Growth Scenario sees a low growth in electricity demand, some conversion from oil to electricity and very little growth in export.
- Alberta and British Columbia: In the High Growth Scenario one of the two units will be for the Tar Sands. The other will be committed on account of environmental pressure on coal and hydraulic. In the Medium Growth Scenario there is one unit forecast for the Tar Sands.
- Export: The High Growth and Medium Growth Scenarios see Canada developing internationally acceptable safeguard criteria and becoming world competitive in financing, and marketing.

ECONOMIC BENEFITS ASSOCIATED WITH SCENARIOS

Models were developed to determine the economic and employment benefits arising out of the scenarios. The benefits are shown graphically in Figures 1 to 4 on pages 40 through 43 and in tables in Appendices 5 to 8.

In 1980 the construction of CANDU electric generating stations resulted in 2.0 billion dollars of business to Canadian industry, 14,200 man years of direct employment and 39,900 man years of total employment. This will decrease approximately 30% by 1983 to 1.35 billion dollars of business, 10,300 man years of direct employment and 29,000 man years of total employment.

The High Growth Scenario would see the business and employment levels returning to the 1980 level by 1986, growing another 50% by 1990 and growing to 5.67 billion dollars of business activity, 37,400 man years of direct employment and 105,000 man years of total employment by 1995 after which growth will continue at a lower rate.

The Medium Growth Scenario would see the business and employment levels returning to approximately 90% of the 1980 level by 1985, staying fairly level to 1990, passing the 1980 level in 1991 and growing steadily to almost twice the 1980 level by the year 2000.

The Low Growth Scenario would see business activity and employment vary ± 25% from the 1983 levels until the mid 1990's after which they would return to the 1980 level. Business generated by this scenario would not support all of the companies that presently participate in the CANDU program. Those that survive will have to do so in a way which will enable them to continue to effectively support CANDU.

ECONOMIC BENEFITS ARISING FROM A DOMESTIC CANDU UNIT AND AN EXPORT CANDU UNIT

The schedule for a CANDU Unit is approximately eight years. The economic activity associated with various CANDU units is

	850MWe Unit in Four Unit Station	850MWe Unit Stand Alone	600MWe Unit Stand Alone
Business Activity-Millions 1981 $	641	1026	626
Direct Employment-Man Years	8,000	12,800	7,800
Total Employment-Man Years	22,500	36,000	21,960

Heavy water, nuclear fuel and distributables are additional to this.

A unit sold in the export market provides about half this amount of activity, most of which is in the high technology part of the business

TANGIBLE BENEFITS ARISING FROM PRESENT CANDU PROGRAM

Some of the tangible benefits arising from the CANDU electric generating station program are:

- reduced cost of electricity in Ontario
- development of an indigenous high technology industry.
- development of high quality standards for products and services.
- enhanced perception of Canada's industrial capability.
- offset the need to import 2.1 billion dollars of coal from the United States from 1971 to the end of 1980.

CONCLUSIONS

Some conclusions which can be drawn from the report are:

- the economic benefits arising from a CANDU power plant program are significant in job creation, quality of jobs, avoidance of foreign exchange expenditures and in a gain on foreign exchange.
- there will be a sharp drop in capital expenditures and employment until 1983 or 1984.
- some companies will withdraw from the nuclear industry during the next several years because of the volume of business. Designers will be the first to feel this impact.
- the nuclear industry has the capacity to handle the load forecast in the High Growth Scenario well into the 1990's.
- a viable nuclear industry is heavily dependent on Canadian Utilities.

OVERVIEW OF NUCLEAR INDUSTRY IN CANADA TOUCHING ON

- RESEARCH AND DEVELOPMENT
- NUCLEAR FUEL MANUFACTURING
- RADIONUCLIDES FOR INDUSTRY AND MEDICINE
- OPERATION AND MAINTENANCE OF CANDU ELECTRIC GENERATING STATIONS AND HEAVY WATER PLANT
- REGULATORY AGENCIES

A large percentage of the Nuclear Research and Development in Canada is carried on by Atomic Energy of Canada Limited (AECL) Research Company. Other organizations involved in this activity are Ontario Hydro, Atomic Energy Control Board, Eldorado Nuclear Limited, TRIUMF, Hydro Quebec

and some private companies. In 1980 - 81 the activity accounted for employment of approximately 3450 persons and expenditures in excess of $160 million, over 85% of which was provided by the Government of Canada.(1)
Nuclear Fuel Manufacturing is carried on by three companies who delivered 1100 metric tons of fuel in 1980 and employed 649 persons.(2)
It is expected that deliveries will grow to 2100 metric tons in 1990.
AECL Radiochemical Company is the dominant company in the radionuclide industry in Canada. It sells medical equipment, industrial equipment and isotopes world-wide. It has had sustained growth. In the 1980 - 81 fiscal year it had sales of $55.2 million and its order backlog was the highest in its history.(1)

The Operation and Maintenance of CANDU Electric Generating Stations is presently carried out at the ten operating stations in Ontario. These stations produced 35,579 millions kW.h of electricity in 1980, 34 percent of Ontario Hydro's total generation. It is estimated that it cost $520 million to produce this which is less than 22 percent of Ontario Hydro's total cost in 1980.(3) Fourteen more stations will come into service in Canada during this decade.

The Operation and Maintenance of Heavy Water Plants is carried on by Ontario Hydro and AECL Chemical Company. In 1980 over 1200 metric tons of heavy water were produced.(4) The future of this business is dependent on the committing of CANDU electric generating stations after Darlington A and the two units in Romania.

The major regulatory activity in the nuclear industry in Canada is carried on by the Atomic Energy Control Board (AECB). In 1980 the Board's expenditures were $14 million (5), about 10 percent of which was spent on Research and Development.

ECONOMIC BENEFITS ARISING FROM THE DESIGN, MANUFACTURE AND CONSTRUCTION OF CANDU ELECTRIC GENERATING STATIONS

RECOMMENDATIONS TO THE CNA BOARD OF DIRECTORS

It is recommended that the CNA

- Encourage the provision of work for the engineering sector until new stations are committed. Standardizing the 600 MW reactor design and completing the design of a unit of approximately 1000 MW would provide such work.
- For some constituencies, encourage the development of project contracts with the construction unions to forestall the deleterious effects of strikes and work stoppages on schedules and costs.
- Through its Quebec members, develop information to present to the government of Quebec which will emphasize the value of CANDU to the Quebec economy.
- Through its Ontario members, support the Ontario Government in its thrust for electricity.
- Develop a program aimed at assisting utilities to increase the export of electricity.
- Develop information in support of "pre-build" CANDU electric generating stations for the export of the electricity.
- Develop information to present to the federal government concerning its financing of CANDU electric generating stations in those constituencies where the capital cost would be a high proportion of the debt load.
    - . When a station is operating the funds would be repaid on the same basis as for any other lender.
- Establish two way communication with federal government on the development of non-proliferation controls and safeguards.
- Seek liaison with the federal government to develop financing and marketing which are world competitive.
- Keep a watching-brief for the opportunity to enter the United States market for nuclear electricity generating stations.

EMPLOYMENT AND ECONOMIC ACTIVITY IN THE CANADIAN NUCLEAR INDUSTRY

Economic Development Committee
Canadian Nuclear Association
Revised March 16, 1982

NUMBER OF PERSONS EMPLOYED IN THE CANADIAN NUCLEAR INDUSTRY

IN 1980

Column 1		Column 2	
Uranium Industry		Reactor Study[12]	
Exploration	500[1][2]	Manufacturing	5,400
Mining & Milling	6,068[1]	Construction	3,700
Refining	892[3]	Engineering	2,100
Fuel Fabrication	649[4]	Heavy Water	2,800
	8,109	Fuel	200
			14,200
Utilities		Duplication with Persons in Column 1	
Ontario Hydro	12,578[5]	Construction	3,700
Hydro Quebec	1,460[6]	Engineering	2,100
NBEPC	2,165[7]	Heavy Water	2,800
Total Utilities	16,203	Fuel	200
			8,800
AECL	7,512[8]		
Other Research and Development	200[9]		
Consultants	1,000[10]	Net Reactor Study	5,400
Regulatory (AECB)	190[11]		
Net Reactor Study	5,400		
Total	38,614		

Not estimated - Personnel in government departments, ministries or agencies other than AECB, Universities, specialized manufacturers, and persons under contract to mining companies during the time prior to the start of mining, other than for exploration.

ECONOMIC ACTIVITY OF THE CANADIAN NUCLEAR INDUSTRY IN 1980

				Millions of Dollars
1.	**Uranium**			
	1.1 Shipments			
	- Production - 7145 tonnes U[1]			
	- Shipments - 6368 tonnes U[13]			638[13]
	1.2 Eldorado			
	- Refining	$ 40.7		
	- Other	10.6		
		$ 51.3		51[3]
	1.3 Exploration			130[1]
	1.4 Fuel Fabrication			48[4]
	Sub-Total			867
2.	**AECL**			
	2.1 Commercial Revenues	$570		
	2.2 Research & Development	141		
	2.3 Prototype Reactors	35		
	Sub-Total	$746		746[8]
3.	**Ontario Hydro**			
	3.1 Total Revenues		$2,819	
	3.2 Nuclear Revenues			
	$2,819 $\times \frac{35,579 \times 10^6 \text{ kw.h Nuclear}}{111,565 \times 10^6 \text{ kw.h Total}}$		$ 899	899[14]
4.	**Consultants**			
	1000 man years x 1575 hrs/yr. x $50/hr.			79[10]
	Sub-Total Carried Forward			$2,591

Sub-Total Brought Forward		$2,591
5. Reactor Study[12]		
Major Equipment	364	
Bulk Materials	213	
Labor	263	
Engineering	158	
Heavy Water	497	
Half Fuel Charge	24	
Distributables	503	
	2,022	
Duplication with Previous Items		
Engineering	158[8][10]	
Heavy Water	120[8]	
Half Fuel Charge	24[3][4][13]	
	302	
Net Reactor Study	1,720	1,720
6. AECB		14[8]
7. Other Research and Development Including TRIUMF and IREQ		20[9]
		$4,345

REFERENCES

1. Merlin, H.B. "Canada's Uranium Supply Potential"
Presented to Atomic Industrial Forum/Canadian Nuclear Association Joint International Conference on Uranium, Quebec City, September 15-18, 1981.

2. Private communication from N.M. Ediger, Eldorado Nuclear Limited to Norman Aspin, President - Canadian Nuclear Association, July 28, 1981.

3. Eldorado Nuclear Limited, Annual Report 1980.

4. Estimating the Costs of AECB Regulation"
SECOR INC., April 1981.

5. Private communication from R.T. Matsunaga, Ontario Hydro, January 4, 1982.

6. Private communication from Louis F. Monier
Hydro Quebec, February 15,1982.

7. Private communication from C.T. Flynn, New Brunswick Electric Power Commission, January 8, 1982.

8. Atomic Energy of Canada Limited, 1980-81 Annual Report.

9. Estimated by Committee.

10. Private communications from various consultants and an estimate.

11. Atomic Energy Control Board Annual Report, 1980-81.

12. Economic Benefits Arising from the Design, Manufacture and Construction of CANDU Electric Generating Stations, Canadian Nuclear Association, November 1981.

13. R.T. Whillans, "Uranium, Uranium, Uranium, Uranium, Uranium", Canadian Mining Journal, Vol. 102, No. 2, February, 1981.

14. Ontario Hydro Annual Report 1980.

CANADIAN URANIUM INDUSTRY 1981 - 1990

This brief analysis of the Uranium Industry covers the following:

- recent statistical information on Canadian producing operations in mining, milling and refining.

- four possible scenarios for producing operations for the period 1981 - 1990 and the effect of each on capital expenditures, direct employment, production capability and product value.

- a forecast of CANDU nuclear fuel deliveries.

- a look at exploration expenditures.

The sources of information on which the above analysis is based are appropriately identified.

RECENT STATISTICAL INFORMATION FOR URANIUM MINING, MILLING, AND REFINING

Some recent statistical information on production, shipments and manpower for uranium mining and milling and for Eldorado Nuclear Limited is shown in Table 1.

TABLE 1

CANADIAN PRODUCING OPERATIONS - URANIUM MINING, MILLING & REFINING

Uranium Production - Tonnes U

	1976	1977	1978	1979[1]	1980[2]	Work Force 1979[1]	Work Force 1980[2]
Agnew Lake Mines Limited				172	195	300	79
Cluff Mining				--	11		241
Denison Mines Limited				1729	1712	1895	2027
Eldorado Nuclear Limited	457[3]	456[3]	493[3]	387	417	727	845
Gulf Minerals Canada Limited				2065	1960	262	320
Madawaska Mines Limited				233	235	389	381
Rio Algom Limited							
Quirke Mill				2036)	2609	1440	1404
Panel Mill				152)		708	771
CENEX				43	6	--	--
Total				6817	7145	5721	6068

Shipments from Production and Inventory

Quantity - Tonnes U				8211[1]	6530[4]	6368[4]	
Value ($ x 10^6)				618[1]	616[4]	638[4]	

Eldorado Port Hope Production[3] - Tonnes U

UF_6	3325	3867	3219	4486	4246		
UO_2	505	841	966	1324	965		
Total	3830	4708	4185	5810	5211		

Eldorado Total Number of Employees[3]

	1105	1288	1499	1610	1737		

Total Work Force - 1980 (6068 + 1737 - 845) 6960

1. "Uranium in Canada - 1979 Assessment of Supply and Requirements, Energy, Mines and Resources Canada, Report EP 80-3, September 1980.
2. "Uranium in Canada - 1980 Assessment of Supply and Requirements", Energy Mines and Resources Canada Report EP 81-3 September 1981.
3. Eldorado Nuclear Limited - Annual Report 1980.
4. R.T. Whillans, "Uranium, Uranium, Uranium, Uranium, Uranium", Canadian Mining Journal, Vol. 102, No. 2, February 1981.

SCENARIOS FOR CANADIAN URANIUM INDUSTRY 1981 - 1990

The following scenarios were prepared for the Economic Development Committee by Mr. H.B. Merlin, a member of the committee and Mr. R.M. Williams. Messrs. Merlin and Williams are members of the staff of Energy, Mines and Resources Canada.

The scenarios are:

SCENARIO A - NO NEW CONTRACTS - PRICES FALL FURTHER BEFORE RECOVERY = SOME EARLY MINE CLOSURES

Assumes
- Price declines to lower levels before recovering by end of decade.
- Only resources in lower price category considered to be economically mineable.
- Only those production projects under construction at end of 1980 proceed; certain producers cease operations for economic reasons before 1985.
- No refinery projects proceed.

SCENARIO B - DEMAND SLACKENS, PRICES REMAIN LEVEL = NO NEW GROWTH

Assumes
- No immediate price recovery.
- Only resources in lower cost category considered to be economically mineable.
- Only those projects under construction at end of 1980 are completed.
- No new refinery projects.

SCENARIO C - DEMAND STEADY, PRICES STABILIZE AND BEGIN TO RISE = EXPANSION

Assumes
- Prices climb slowly.
- Resources in lower cost category considered to be economically mineable.
- Projects currently planned proceed.
- Ontario refinery projects proceed.

SCENARIO D - DEMAND INCREASES, PRICES RECOVER MORE RAPIDLY THAN B = ACCELERATED GROWTH

Assumes
- Prices exceed $US 50/lb U_3O_8 by 1990.
- Some resources in the higher cost category now economically recoverable.
- All projects envisaged in 1980 that could be supported by known deposits, including those in B.C., go ahead.
- Both Ontario and Saskatchewan refinery projects proceed.

Figure 1 shows the capital expenditures, direct employment, production capability and product value which would be associated with each scenario. The price assumptions for the product value are:

TABLE 2

PRICE ASSUMPTIONS

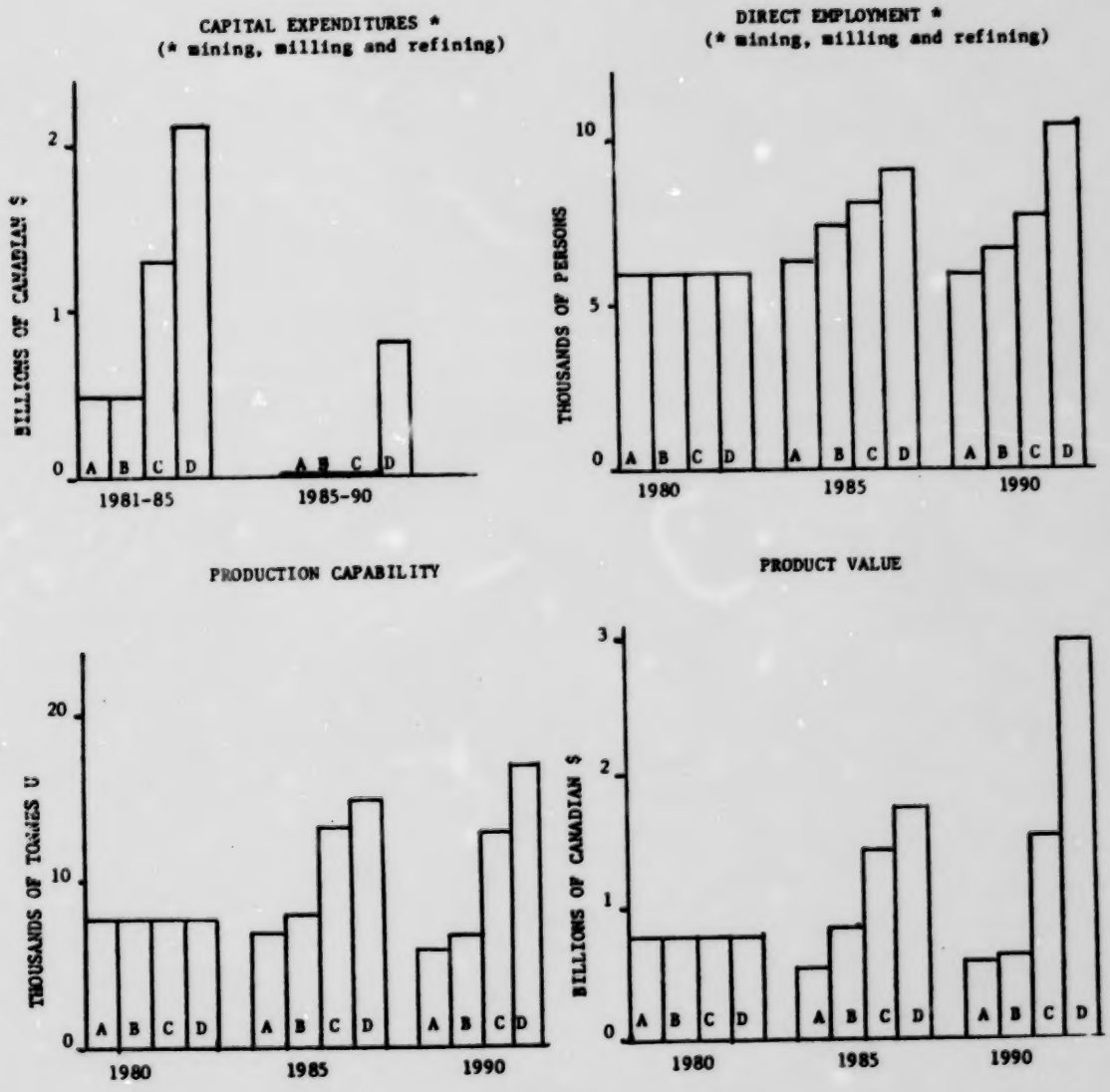
(in 1981 dollars $CDN/kg U and $US/lb U_3O_8)

	1981	1985	1990
Scenario A	$C100/33	80/26	100/33
Scenario B	100/33	100/33	100/33
Scenario C	100/33	110/36	120/40
Scenario D	100/33	120/40	180/60 $US

Notes:

1. Prices are not market prices but average prices for total deliveries developed for the purpose of estimating total value of Canadian production.
2. Employment figures refer to direct employment and exclude head-office, exploration and marketing personnel. Figures for 1980 also excluded the Port Hope refinery.
3. Capital cost figures are estimates (in some cases very rough) for forward capital project costs based on published references. They do not include on-going costs for replacement of such things as machinery and equipment at operating projects.
4. Production levels are based on production capability estimates prepared by EMR's Uranium Resource Appraisal Group for its 1979 Assessment, as published in ER80-3, September 1980.

FIGURE 1


CAPITAL EXPENDITURES *
(* mining, milling and refining)
BILLIONS OF CANADIAN $
2
1
0
A B C D
A B C D
1981-85
1985-90
DIRECT EMPLOYMENT *
(* mining, milling and refining)
THOUSANDS OF PERSONS
10
5
0
A B C D A B C D A B C D
1980
1985
1990
PRODUCTION CAPABILITY
THOUSANDS OF TONNES U
20
10
0
A B C D A B C D A B C D
1980
1985
1990
PRODUCT VALUE
BILLIONS OF CANADIAN $
3
2
1
0
A B C D A B C D A B C D
1980
1985
1990

In Figure 1, the employment for Scenario A stays level during the period. This is due to the fact that the producing mines which have uranium sales contracts and most of which are labour intensive will continue operating.

For Scenario B, the employment level is shown higher for 1985 than 1980 even though production stays level. This is forecast to occur because the Gulf Minerals Canada Limited (Rabbit Lake) mine is expected to close and Rio Algom Limited (Stanleigh Mine) is expected to be in operation. The latter will be significantly more labor intensive than Rabbit Lake.

Figure 1 is self-explanatory. Scenario A is very pessimistic, Scenario B is just a holding position and the other Scenarios show significant growth in the uranium business.

During the forecast period CANDU fuel deliveries in Canada will grow from 1000 tonnes U in 1981 to approximately 2000 tonnes U in 1990 (Figure 3). As a result significant growth in the uranium market will depend on orders for export.

FORECAST OF CANDU NUCLEAR FUEL DELIVERIES

The Economic Development Committee is doing studies on other segments of the Canadian Nuclear Industry. Four scenarios, one of which is the existing situation, were prepared for nuclear generating stations.

Table 3 shows the "In-service" year for nuclear generating stations for Scenarios 2, 3 and 4.

CANDU Fuel Deliveries to reactors in Canada are shown in Figure 2. It is evident that only Scenario 1, the existing situation, has an effect on fuel deliveries prior to 1991. The forecast fuel deliveries are based on Ontario Hydro experience. If other Canadian utilities are not successful in achieving Ontario Hydro's historic capacity factor, the deliveries shown would be proportionately lower.

TABLE 3

CANDU GENERATING STATIONS IN SERVICE-MWe- SCENARIOS 1, 2 & 3- 1991 to 2000

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	total
Scenario 1 High Growth											
Maritimes	600					600			600		1800
Quebec		850			850	850	850	850	850	850	5950
Ontario			850	850	850	850	850	850	850	850	6800
West						600			600		1200
Total	600	850	850	850	1700	2900	1700	1700	2900	1700	15,750
Scenario 2-Medium Growth											
Maritimes	600								600		1200
Quebec		850			850		850		850	850	4250
Ontario				850	850	850	850	850	850		5100
West							600				600
Total	600	850		850	1700	850	2300	850	2300	850	11,150
Scenario 3-Low Growth											
Maritimes	600										600
Quebec									850		850
Ontario				850	850		850	850			3400
West											
Total	600			850	850		850	850	850		4850

EXPLORATION FOR URANIUM

During the years 1977 to 1979 uranium exploration in Saskatchewan accounted for more than 50% of the expenditures and more than 60% of the drilling activity for Canada. Table 4 gives details concerning this.

TABLE 4

URANIUM EXPLORATION - EXPENDITURES AND ACTIVITY

Uranium Exploration Expenditures in Canada by Province or Territory, 1977, through 1980

	1977[1]	1978[2]	1979[2]	1980[3]
	(millions of dollars)			
Saskatchewan	35.3	43.6	70.5	77.2
Northwest Territories	13.8	17.0	26.4	29.1
Quebec	8.4	7.4	7.0	6.4
Newfoundland	2.3	2.8	6.8	3.7
British Columbia	2.2	7.0	3.9	0.6
Nova Scotia	1.5	2.4	3.8	4.5
Yukon Territory	0.8	1.0	2.7	1.3
New Brunswick	1.0	1.2	2.3	1.4
Ontario	2.6	2.3	2.1	1.7
Alberta	1.0	1.1	1.6	1.0
Manitoba	0.4	0.2	0.6	1.1
Unspecified	2.4	4.0	1.8	0.3
Total	71.7	90.0	129.5	128.3

*Does not include expenditures on EMR's Uranium Reconnaissance Program.

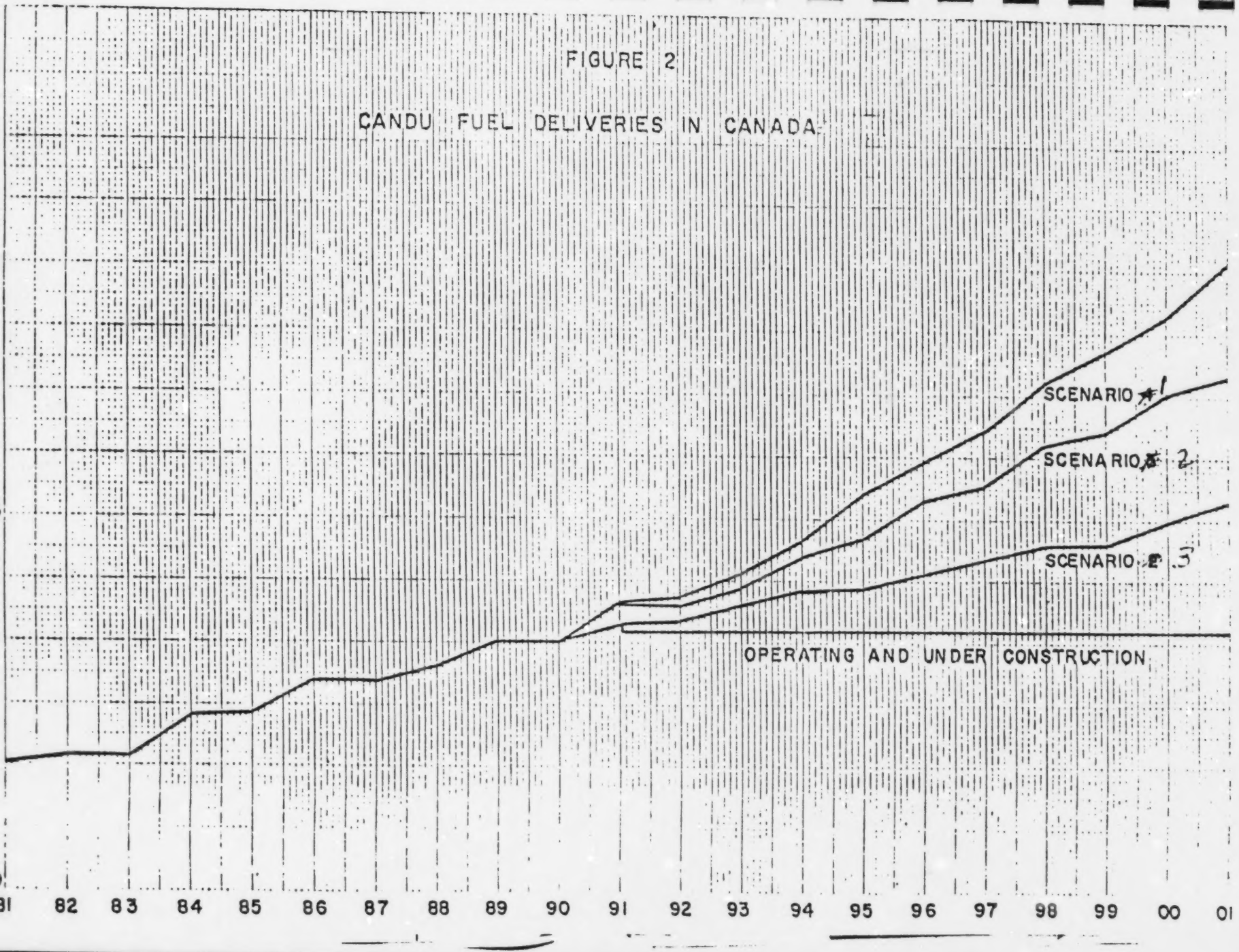
Uranium Exploration Drilling and Surface Development Drilling Activity in Canada, by Province or Territory, 1977 through 1980

	1977[1]	1978[2]	1979[2]	1980[3]
	(thousands of metres)			
Saskatchewan	192.4	233.4	326.6	368.6
Northwest Territories	14.3	18.9	45.6	55.1
Ontario	24.7	11.0	24.2	11.1
Newfoundland	6.1	6.8	20.6	8.1
Quebec	35.9	21.1	19.5	24.1
British Columbia	18.1	25.4	18.4	0
Nova Scotia	1.9	9.7	13.9	16.4
Yukon Territory	0.6	0.4	5.5	1.0
New Brunswick	4.1	2.8	3.6	9.1
Manitoba	--	--	2.3	2.9
Alberta	3.9	3.9	1.7	1.7
Unspecified	2.1	0.4	1.4	5.3
Total	304.1	333.9	483.3	503.4

1. "1978 Assessment of Canada's Uranium-Supply and Damand", Energy, Mines & Resources Canada, Report EP 79-3, June 1979.
2. "Uranium in Canada-1979 Assessment of Supply and Requirements", Energy, Mines & Resources Canada, Report EP 80-3, September 1980.
3. "Uranium in Canada-1980 Assessment of Supply and Requirements", Energy, Mines and Resources Canada, Report EP 81-3, September 1981.

FIGURE 2

CANDU FUEL DELIVERIES IN CANADA



Exploration activity is so varied that it is almost impossible to equate expenditures with man years. An analysis performed by James Bay Development Corporation for 1977 and 1978 showed that each man year of effort accounted for $ 140,000 of exploration. Mr. N.M. Ediger, believes that each man year of exploration effort currently results in direct expenditures of approximately $ 250,000.

Table 5 shows estimated expenditures on uranium exploration in Saskatchewan, over the period 1981-1995. This information was provided by David R. Francis, Executive Vice-President - Operations, Saskatchewan Mining Development Corporation. This forecast is based on work requirements to hold prime properties in good standing and to allow for some new grass roots exploration.

In the event that activity in Saskatchewan remains at the proportion for all of Canada as during the years 1977 through 1979, exploration activity will be lower than 1978 activity until at least 1995.

TABLE 5

SASKATCHEWAN

ESTIMATED URANIUM EXPLORATION EXPENDITURES

1981 - 1995

(millions of 1981 Canadian dollars)

Year	Minimum Level	Probable Level	High Level
1981	45	45	45
1982	30	37	40
1983	24	34	37
1984	20	32	35
1985	17	30	33
1986	20	33	36
1987	22	34	37
1988	24	35	37
1989	25	36	40
1990	26	37	42
1991	26	37	42
1992	26	37	42
1993	27	38	43
1994	28	39	44
1995	30	40	45

ECONOMIC BENEFITS ARISING FROM THE DESIGN, MANUFACTURE AND CONSTRUCTION OF CANDU ELECTRIC GENERATING STATIONS

Canadian Nuclear Association
111 Elizabeth Street
Toronto, Ontario, M5G 1P7

Sub-Committee

W.C. Durant, Chairman
S.N. Advani
N. Aspin
J.G. Charuk
P. Giurlanda
H.H. Leng
P. Pickerill
R.A. Reid
A. Yu

November 1981

Revised - March, 1982

INTRODUCTION

This report shows the potential economic benefits to the year 2000 arising from the construction of CANDU electric generating stations at home and abroad. Three scenarios are developed for the domestic and export markets and comparisons are made with other recent forecasts. Conclusions are drawn and recommendations aimed at maintaining the viability of business associated with the construction of CANDU's are made.

Input data based on recent CANDU construction experience was supplied by Ontario Hydro, Hydro Quebec, New Brunswick Power and AECL to establish the economic and manpower activity levels associated with CANDU plant construction. Ontario Hydro kindly made available facilities to assimilate and analyze the economic and employment impact of the scenarios.

PURPOSE

The report provides information to the Board of Directors of the Canadian Nuclear Association on:

- the opportunities for those companies which supply goods and services in the design, manufacture and construction of CANDU stations.
- the value of this industry to Canada in terms of job opportunities, impetus to high technology industry, and staunching the outflow of dollars for coal and oil.
- actions which the CNA can initiate to help ensure the viability of the industry.

PRESENT COMMITMENTS

The Present Commitments are included primarily as a base line against which the three scenarios can be compared. It has a second purpose in that it corresponds to one of the scenarios considered by the Federal nuclear review, and it illustrates the results of that eventuality. Present commitments include all of the stations which are currently under construction.

PRESENT COMMITMENTS

NUCLEAR POWER PLANTS

IN DESIGN AND CONSTRUCTION PHASE

	Station	Units	Net Capacity-MWe[1]
Canada			Total
New Brunswick	Point Lepreau	1	630
Quebec	Gentilly 2	1	638
Ontario	Pickering B	4	2,064
	Bruce B	4	3,024
	Darlington A	4	3,524
Total Canadian		14	9,880
Export			
Argentina	Cordoba 1	1	600
Korea	Wolsung 1	1	629
Romania	Cernavoda	2	1,200
Total Export		4	2,429
Total		18 units	12,309 MWe

CANDU plants which are operating and are under construction are listed in Appendix 1.

SCENARIOS

Three scenarios have been developed in this study. These are High Growth, Medium Growth and Low Growth. In order to provide economic and employment data to the year 2000, forecasts for CANDU plants "In Service" have been made to the year 2012. In the High Growth Scenario the "In-Service" MWe for CANDU stations in the period 1991 to 2012 represents an annual growth from the 1990 total proposed capacity [2] of approximately 2.6% for Nova Scotia and New Brunswick, 2.1% for Ontario, 2% for Quebec and 1.1% for Alberta and British Columbia. A few CANDU plants devoted to the export of electricity have been included in the High and Medium Growth Scenarios.

SCENARIO 1 - HIGH GROWTH

This scenario assumes a modest improvement in the national economy. It assumes 3.5% growth in electricity demand from 1980 to 2000 for Ontario, 2.5% growth in Quebec for that portion of electricity demand which will be provided by CANDU electric generating stations and 4% growth in New Brunswick and Nova Scotia. It sees the displacement of oil and some coal by nuclear, the displacement of oil in space heating by more electricity than in the medium and low growth scenarios and the "pre-building" of some plants for the export of electricity. It also sees the export sale of thirteen units for "In Service" during the 1990's.

The units included in this scenario make up approximately 10% of the free world reactor market from 1991 to 2000. [3][4]

SCENARIO 1 - HIGH GROWTH

	1991 to 2000			2001 to 2012		
	Units	Nominal MWe Per Unit	Total MWe	Units	Nominal MWe Per Unit	Total MWe
Canada						
New Brunswick and	3	600	1800	1	600	600
Nova Scotia				2	950	1900
Quebec	7	850	5950	12	850	10200
Ontario	8	850	6800	16	850	13600
Alberta and	2	600	1200	1	600	600
British Columbia	—		—	4	850	3400
Total Canadian	20	-	15,750	36	-	30300
Export	13	600	7,800	16	950	15200
Total	33		23,550	52		45500

In addition to those stated above, the following assumptions have been made:

New Brunswick and Nova Scotia:

The three 600 MWe station in the period 1991 to 2000 will occur due to replacement of coal and oil, growth in domestic electricity demand and in the export of electricity.

The two 950 MWe units in the period 2001 to 2012 will be dedicated to export of electricity.

Quebec:

The successful operation of Gentilly 2 will allow the Quebec government to reconsider its full dependence on the long distance transmission of hydro electric power with the result that some nuclear generating stations will be built closer to the centres of demand. Some hydro electric power will be needed however to meet the expected growth in electricity demand.

Ontario:

Two of the units in the period 1991 - 2000 will be "pre-built" and used for the export of electricity.

West:

The two 600 MWe units in the period 1991 to 2000 are for the Tar Sands, some growth and environmental pressure on coal and hydro.

In the 2001 to 2012 period at least two of the 850 units will be dedicated to export. All the units will be in Alberta and/or British Columbia.

Export:

The 13 - 600 MWe units in the period 1991 to 2000 are an indication of what is really available if Canadian financing and marketing are competitive by world standards and internationally acceptable safeguard criteria are developed.

The same comments apply to the sixteen units in the period 2001 to 2012.

SCENARIO 2 - MEDIUM GROWTH

This scenario assumes some improvement in the national economy. Growth in nuclear electricity demand is less than for Scenario 1 mainly because nuclear does not displace as much coal or hydraulic as in that scenario. This scenario agrecs quite well with utility estimates for the period 1991 to 2000[2] and also with SECOR's[5] median prediction for installed CANDU capacity by the year 2000.

The units included in this Scenario make up just over 5% of the free world reactor market from 1991 to 2000[3][4].

SCENARIO 2 - MEDIUM GROWTH

	1991 to 2000			2001 to 2012		
	Units	Nominal MWe Per Unit	Total MWe	Units	Nominal MWe Per Unit	Total MWe
Canada						
New Brunswick and Nova Scotia	2	600	1,200	1	600	600
Quebec	5	850	4,250	12	850	10,200
Ontario	6	850	5,100	12	850	10,200
Alberta and British Columbia	1	600	600	1 2	600 950	600 1,900
Total Canadian	14	-	11,150	28	-	23,500
Export	4	600	2,400	8	950	7,600
Total	18		13,550	36		31,100

The following assumptions have been made concerning this Scenario:

Maritimes:

Point Lepreau 2 will be committed as soon as Point Lepreau 1 is in service and will have an In-Service date of 1991. Subsequent stations will be committed on the same basis. In the early years of service, sales of electricity from these stations will be for export.

Quebec:

As in the High Growth Scenario, the successful operation of Gentilly 2 will allow the Quebec government to reconsider its full dependence on the long distance transmission of hydro electric power with the result that five nuclear generating stations will be committed closer to the centres of electricity demand.

Ontario:

The six 850 MWe stations to the year 2000 are consistent with the preliminary planning for Ontario Hydro[6]. If the Ontario growth in electricity demand falls below 3% it is possible that one or two of these units will be used for the export of electricity.

During the period 2001 to 2012 growth in electricity demand is forecast to be 2% in this scenario.

West:

In the period 1991 to 2000 the 600 MWe unit is for supplying steam to the Tar Sands. In the period 2001 to 2012, the two 950 MWe CANDU plants will be committed in Alberta and/or British Columbia as a result of increasing environmental concerns about coal and hydro. There should be an opportunity to export some of the electricity from these plants.

Export

The export prospects in the period 1991 to 2000 are two additional units for Romania, at least four for Mexico, and single units for Korea, Yugoslavia and several other countries. The four units shown to the year 2000 together with the eight units in subsequent years are judged to be the most probable result of a serious national effort to export CANDU electric generating stations.

SCENARIO 3 - LOW GROWTH

This Scenario forecasts lower growth in electricity demand in Ontario, a continuing emphasis on hydro electric development in Quebec, one CANDU reactor to provide steam for the Tar Sands in Alberta to be in service in 2001, and only one export order for CANDU plants in the 1980's. It is slightly higher than the EMR Base Case[7].

SCENARIO 3 - LOW GROWTH

	1991 to 2000			2001 to 2012		
	Units	Nominal MWe Per Unit	Total MWe	Units	Nominal MWe Per Unit	Total MWe
Canada						
New Brunswick	1	600	600	-	-	-
Quebec	1	850	850	3	850	2,550
Ontario	4	850	3,400	4	850	3,400
West				1	600	600
Total Canadian	6		4,850	8		6,550
Export	1	600	600	6	950	5,700
Total	7		5,450	14		12,250

The "In-Service" years for the stations forecast in Scenarios 1, 2 and 3 are shown in Appendix 2.

The effect each of these scenarios would have on the growth in CANDU "In-Service" MWe is shown in the figures 5 and 6 in Appendix 3.

COMPARISONS

The "In-Service" MWe forecast in the Scenarios has been compared with other data and forecasts for Canada. These comparisons are shown below.

1. Comparison with Committed Generating Capacity to 1990

Table 1 shows the comparison with data obtained from Canadian Utilities by Energy Mines and Resources, Canada[2].

Table 1

Comparison of Scenarios for Canada with 1980 Actual Electricity Generating Capacity and 1990 Planned Electricity Generating Capacity

	Actual Generating Capacity December 1980		Planned Generating Capacity 1990		Nuclear Scenarios 1991 - 2000		
	Total MWe[a]	Nuclear MWe	Total MWe[a]	Nuclear MWe	High MWe	Medium MWe	Low MWe
Nova Scotia & New Brunswick	4,923 (2,581)[b]	-	5,776 (2,581)[b]	630	1,800	1,200	600
Quebec	16,862 (636)	250	33,670 (636)	888	5,950	4,250	850
Ontario	25,719 (2,330)	5,226	35,249 (2,330)	13,838	6,800	5,100	3,400
Alberta & British Columbia	16,567 (170)	-	24,115 (170)	-	1,200	600	-

(a) Hydraulic, conventional thermal and nuclear

(b) Oil-fired thermal MWe, included in total

None of the scenarios are an unusually high percentage of the planned generating capacity for 1990 all of which is operating, under construction or in the advanced planning stage. Oil's share of generating capacity in Nova Scotia and New Brunswick is from one-third to four times higher than the forecast additional nuclear to be installed there in the 90's.

It is interesting to note that the high growth scenario for Ontario would just meet electricity demand required for the year 2000 if the load growth rate averaged 3.5% per year from the December 1980 peak of 16,808 MWe and the utility maintained the 25% reserve margin it currently requires to achieve its current standard of system reliability. Although this growth rate is slightly higher than the Ontario Hydro forecast of 3.1 % per year, it is certainly not unrealistic.

2. Comparison with Other Forecasts

In Table 2, the three scenarios in this paper are tabulated along with the SECOR forecast,[5] utility data supplied to Energy Mines and Resources Canada,[2] and a forecast in the Nuclear Policy Review Background Papers[7]. The medium growth of 11,150 MWe is slightly higher than the median of 9995 for SECOR, the 9980 for Electricity in Canada Update 1980, and significantly higher than the median of 7100 in the Nuclear Policy Review Background Papers.

TABLE 2

COMPARISON OF CNA SCENARIOS WITH OTHER CANADIAN FORECASTS

1991 - 2000

	Maritimes	Quebec	Ontario	West	Total
Canadian Nuclear Association					
High Growth					
Units	3	7	8	2	20
MWe	1800	5950	6800	1200	15750
Medium Growth					
Units	2	5	6	1	14
MWe	1200	4250	5100	600	11150
Low Growth					
Units	1	1	4	-	6
MWe	600	850	3400	-	4850
SECOR[5]					
Units	0-4	0-11	2-6	0-2	2-23
MWe	0-2400	0-9350	1760-5280	0-1200	1760-18230
Electricity in Canada Update 1980 (EMR)[2]					
	-	-	-	-	9980
Federal Government Review[7]					
Units	0-1	0-8	2-6	-	2-15
MWe	0-600	0-6800	1700-5100	-	1700-12500

ECONOMIC AND EMPLOYMENT BENEFITS ASSOCIATED WITH THE SCENARIOS

METHOD

Each project type in the current program and envisaged in future programs is identified. The specific CANDU types are:

Under Construction
- Pickering B
- Bruce B
- Darlington
- Domestic 600
  - Lepreau
  - Gentilly 2
- Export 600
  - Cordoba
  - Wolsung

Future
- Domestic
  - Darlington Type
  - 600
  - 950
- Export
  - 600
  - 950

Actual project data was obtained from AECL, Hydro Quebec, New Brunswick Power, and Ontario Hydro to create economic and labour models of projects which have been completed or are currently under construction. An example of such a model is shown in Appendix 4.

METHOD (Cont'd)

These models were adjusted to obtain consistency of format and to select the most probable cost and labour figures where more than one data set was available for a particular statistic. For the 950 MW model, the only one for which a reasonable amount of project data is not available, a model was developed using a combination of AECL's conceptual estimates and extrapolation of actual data from the similar but smaller 600 MW models. All models were adjusted to be in 1981 dollars. The cost and labour expenditure profiles were then applied to each program to calculate the total economic impact and employment resulting.

The data which was calculated was combined in the following categories:

Capital Expenditures ($ 1981)

- Major Equipment
- Bulk Materials
- Labour
- Engineering
- Heavy Water
- Half Fuel Charge
- Distributables
- Total Cost

- Canadian Content
- % Canadian Content

Employment (Man Years)

- Direct
  - Manufacturing
  - Construction
  - Engineering
  - Heavy Water
  - Half Fuel Charge
  - Total Direct

METHOD (Cont'd)

Indirect (Direct x 1.8)

Total Employment

RESULTS

The results of the assimilation and analyses of the data for each Scenario and for the Canadian Market, the Export Market and the total of these is shown in tables in the appendices as listed below:

Appendix 5 - Scenario 1 - High Growth

Appendix 6 - Scenario 2 - Medium Growth

Appendix 7 - Scenario 3 - Low Growth

Appendix 8 - Present Commitments

Graphs have been prepared for total Capital Cost, Direct Employment and Total Employment for the Canadian Market and the Total Market. These are shown in Figures 1 and 2 for the Canadian Market and Figures 3 and 4 for the Total Market.

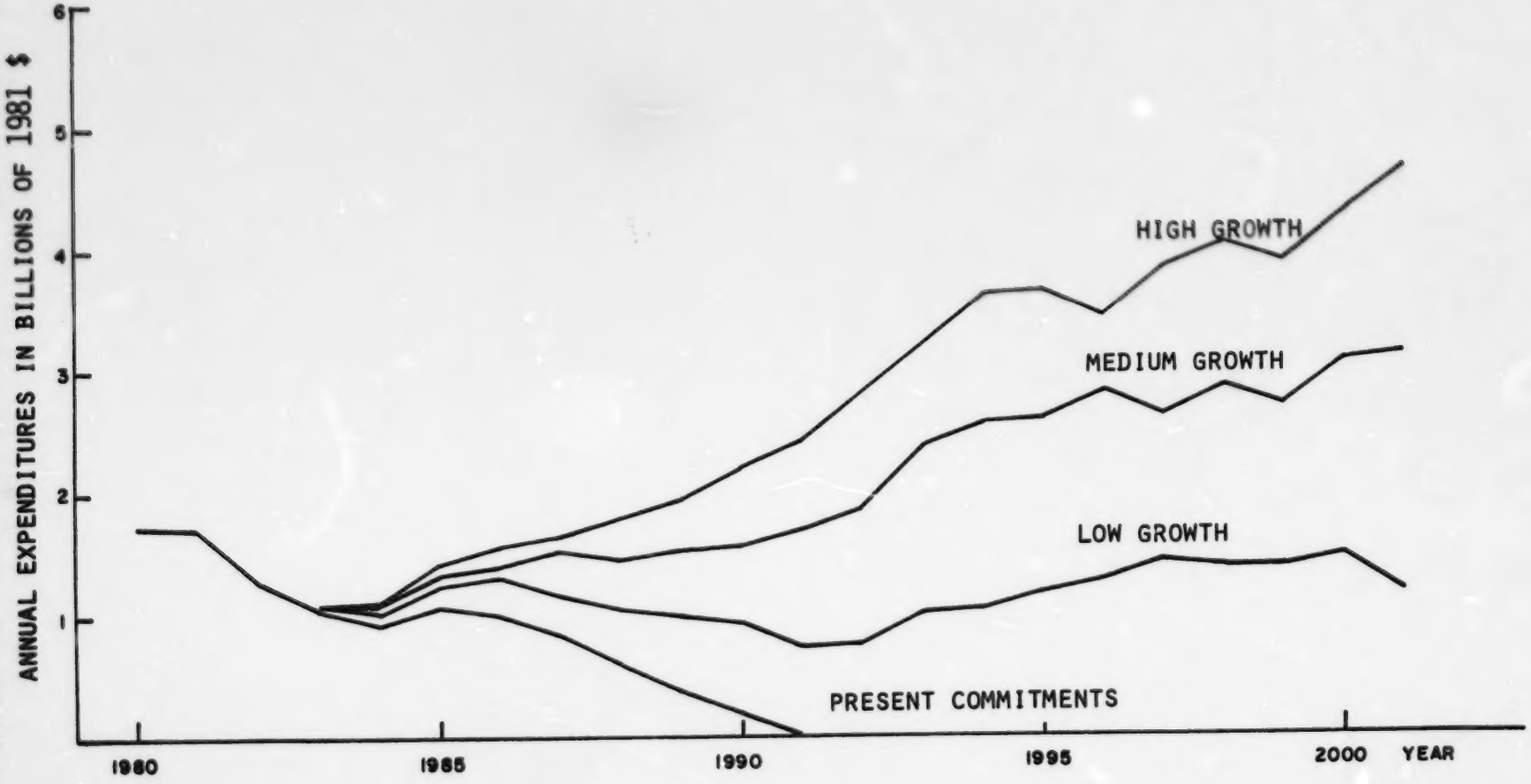


FIGURE 1 CANDU FUTURES - DOMESTIC SCENARIOS - CAPITAL EXPENDITURES

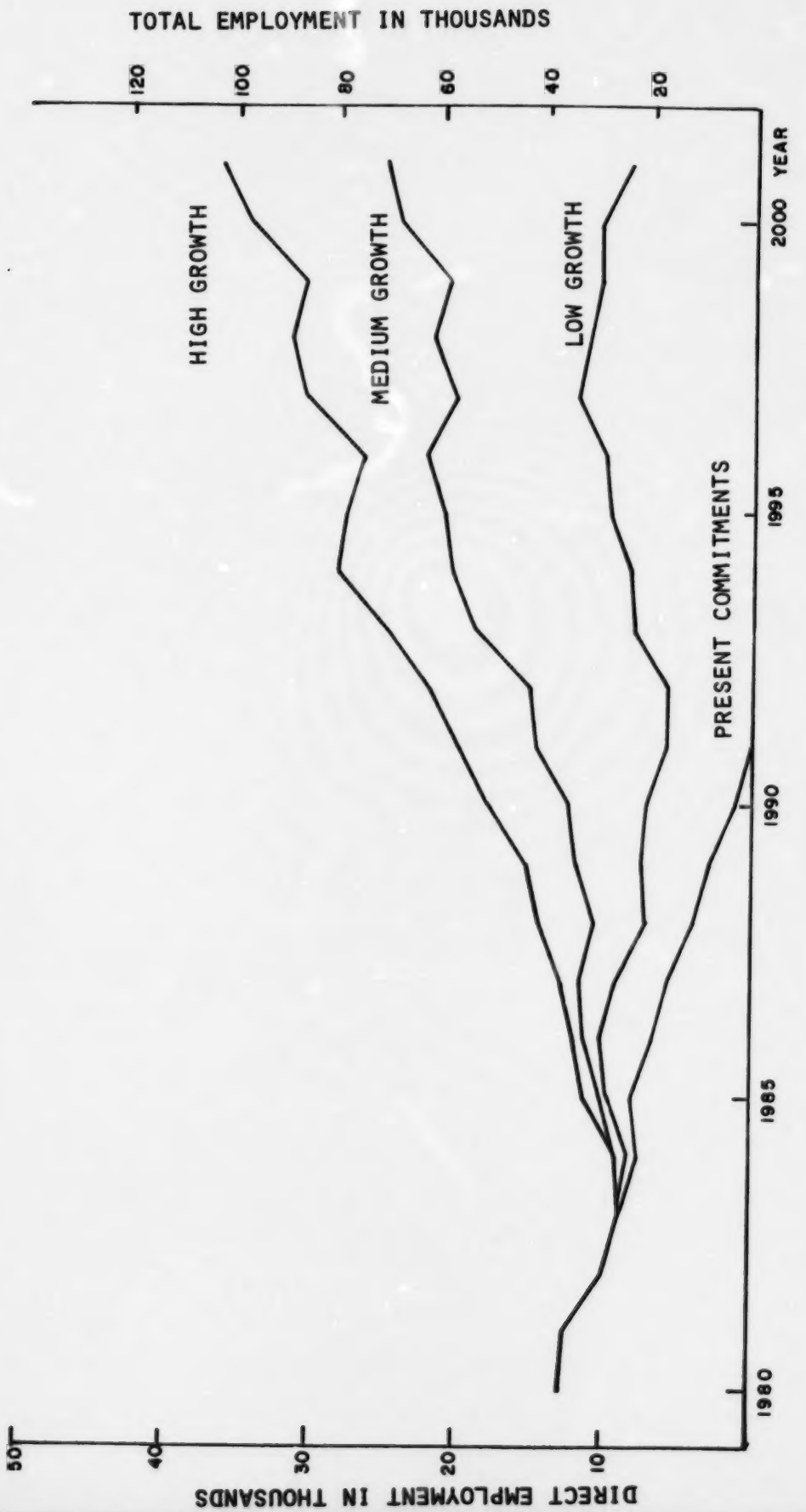


FIGURE 2 CANDU FUTURES - DOMESTIC SCENARIOS-EMPLOYMENT

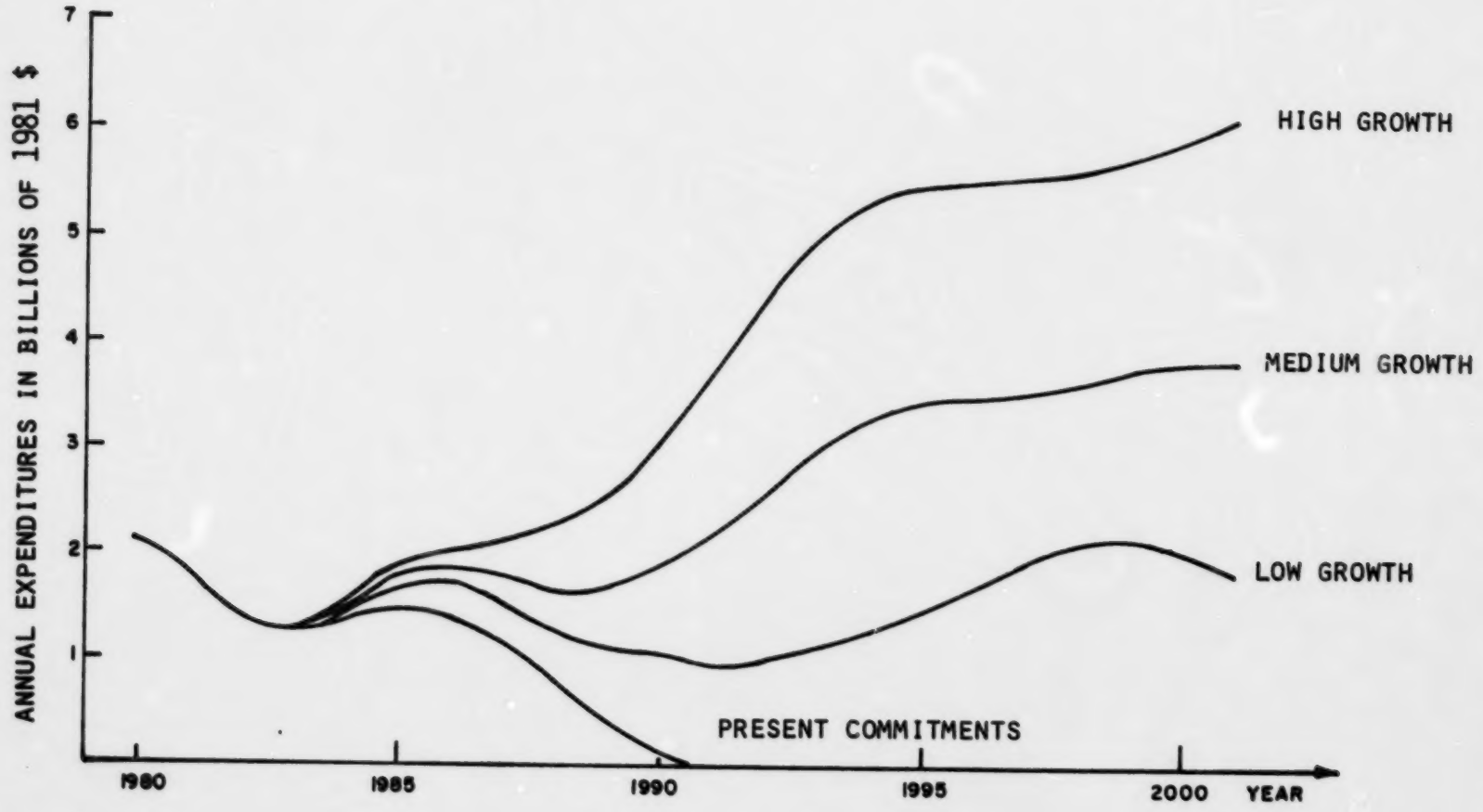


FIGURE 3 CANDU FUTURES - COMBINED SCENARIOS - CAPITAL EXPENDITURES

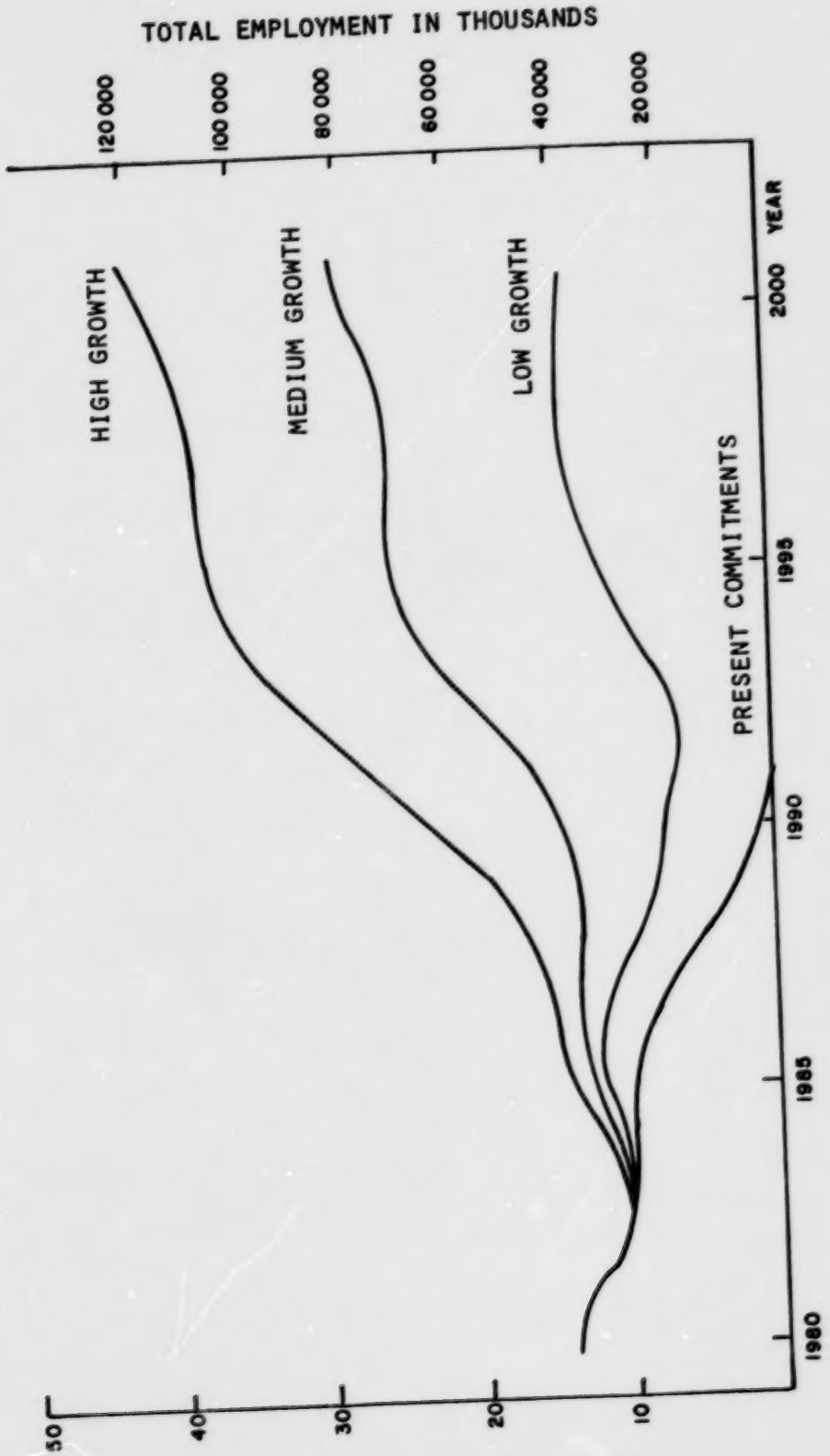


FIGURE 4 CANDU FUTURES - COMBINED SCENARIOS - EMPLOYMENT

POSSIBLE BENEFITS ARISING FROM THE SCENARIOS

In 1980 the design, manufacture and construction of CANDU electric generating stations for service at home and abroad resulted in 2.0 billion dollars of business to Canadian industry, 14,200 man years of direct employment and 39,900 man years of total employment. The present situation is such that this activity will decrease approximately 30% by 1983 to 1.35 billion dollars of business, 10,300 man years of direct employment and 29,000 man years of total employment.

In the event that Scenario 1 - High Growth occurs, the activity after 1983 will begin to grow. It will return to the 1980 level by 1986 and will continue to grow quickly to 3.19 billion dollars, 23,100 man years of direct employment and 64,900 man years of total employment by 1990 and 5.67 billion dollars, 37,400 man years direct employment and 105,000 man years total employment by 1995 after which growth will be significantly slower. Needless to say the benefits associated with this scenario would be very beneficial to the Canadian economy.

Scenario 2 - Medium Growth would result in the activity returning to about 90% of the 1980 level in 1985 and staying fairly even until 1990. In 1991 it would pass the 1980 level and grow steadily to almost twice the 1980 level by the year 2000.

Scenario 3 - Low Growth would result in industrial and employment activity which would vary plus or minus 25% from the 1983 levels until the mid 1990's after which it would return to the 1980 level.

The drop in industrial activity which is taking place now in the nuclear industry will continue until at least 1983. If the High Growth Scenario occurs the companies in the industry will probably find a way to retain their expertise during the drop in activity. The possible announcements and/or commitments which would show a move toward the High Growth Scenario are some of the following: four units for Darlington B, Lepreau 2, some additional units at Gentilly, export sales to Korea, Mexico, Yugoslavia and Romania.

POSSIBLE BENEFITS ARISING FROM THE SCENARIOS (Cont'd)

In the event the Medium Growth Scenaio occurs the larger companies and the "specialized" companies in the industry may find a way to retain their expertise. There will likely be a number of companies withdraw from the industry however.

If the Low Growth Scenario occurs the market for CANDU will be very thin and there will not be enough business for all of the existing suppliers. Those that survive in the Medium Growth or the Low Growth Scenario will have to do so in such a way as to remain technically and financially strong to effectively support CANDU.

ECONOMIC BENEFITS ARISING FROM A CANDU UNIT AND AN EXPORT UNIT

It takes about eight years to design, manufacture and construct a single unit for a CANDU electric generating station. A unit provides the following economic activity over this period.

	850 MWe Unit in Four Unit Station	850 MWe Unit Stand Alone	600 MWe Unit Stand Alone
	Millions of 1981$	Millions of 1981$	Millions of 1981$
Major Equipment	239	382	233
Bulk Material	138	221	135
Labour	168	269	164
Engineering	96	154	94
	$ 641	$ 1026	$ 626
	Man Years	Man Years	
Direct Employment	8,000	12,800	
Total Employment	22,500	36,000	

Canadian content is 80% for major equipment, 95% for bulk material and 100% for labour and engineering.

Heavy water, nuclear fuel and distributables are additional to the above benefits.

A unit sold in the export market will provide about 50% of the economic and employment benefits of a domestic unit. This will be the high technology part of the unit. As a country builds additional CANDU's, the percentage of Canadian contribution will decrease.

TANGIBLE BENEFITS OF CANDU ELECTRIC GENERATING STATION PROGRAM

Some of the tangible benefits arising from the CANDU Electric generating station program are:

- Electricity in Ontario has been less expensive as a result of the success of Pickering A and Bruce A generating stations;
  - o In 1980, the Total Unit Energy Cost was 13.05 mils per kWh from Pickering A compared with 21.60 mils per kWh from Lambton, a coal-fired electric generating station.[8]
  - o The average Ontario householder would have paid $63.00, approximately 19 percent, more for his electricity bill in 1980 if the electricity generated using nuclear had been generated using coal.[9]
- The high technology nature of the CANDU electric generating station has resulted in job creation for highly competent professional and technical persons in the nuclear industry.
- The high quality requirements of the nuclear industry have resulted in the development of high quality standards and in improvement in the products and services in many businesses in Canada.
- The high technology nature of CANDU has enhanced the perception of Canada's industrial capability in foreign countries.
- Nuclear electricity in Ontario has offset the need to import more than 2.1 billion dollars of coal from the United States from 1971 to the end of 1980.[10] [11] This is a significant contribution to Canada's balance of payments. This effect will increase as more nuclear stations are brought into service. By the end of 1981 this savings in U.S. dollars will be equal to the initial capital cost of 2.7 billion dollars [12] for Pickering A and Bruce A Generating Stations.

CONCLUSIONS

The conclusions which can be drawn from this report are:

CONCLUSIONS (Cont'd)

- The economic impact of a CANDU power plant program is significant in job creation, quality of jobs, avoidance of foreign exchange expenditures for coal, scrubber technology and oil, and a gain in foreign exchange provided that an increased emphasis is placed on exporting electricity.
- There will be a sharp decline in Capital Expenditure and Employment until 1983 or 1984 regardless of whether new CANDU power plants are committed in Canada and/or new orders are received for export.
- Thus some of the companies involved in the design, manufacture and construction of CANDU power plants will withdraw from the industry early in the 80's because of the volume of business. Designers will be the first to feel the impact of this.
- The companies involved in the design, manufacture, and construction of CANDU power plants have the capacity to handle the load forecast in the Scenarios well into the 1990's.
- A viable industry associated with CANDU power plant construction is heavily dependent on Canadian utilities, particularly Ontario Hydro and Hydro Quebec.

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8. Private Communication from S.N. Advani, Ontario Hydro, October 30, 1981.

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13. Ontario Hydro Annual Report, 1980.

APPENDIX I

CANDU NUCLEAR POWER PLANTS

REACTORS OPERATING

Canadian	MWe (1)	Location
Douglas Point	206	Ontario
Gentilly 1	250	Quebec
Pickering 1	515	Ontario
Pickering 2	515	Ontario
Pickering 3	515	Ontario
Pickering 4	515	Ontario
Bruce 1	740	Ontario
Bruce 2	740	Ontario
Bruce 3	740	Ontario
Bruce 4	740	Ontario
Export		
RAPP 1	202	India
RAPP 2	202	India
KANUPP	125	Pakistan

REACTORS UNDER CONSTRUCTION

Canadian	MWe	Location	In Service Date
Lepreau	630	New Brunswick	1982
Gentilly 2	638	Quebec	1982
Pickering 5	516	Ontario	1983
Pickering 6	516	Ontario	1983
Pickering 7	516	Ontario	1984
Pickering 8	516	Ontario	1984
Bruce 6	756	Ontario	1983
Bruce 5	756	Ontario	1984
Bruce 7	756	Ontario	1986
Bruce 8	756	Ontario	1987
Darlington 2	881	Ontario	1988
Darlington 1	881	Ontario	1989
Darlington 3	881	Ontario	1989
Darlington 4	881	Ontario	1990
Export			
Cordoba	600	Argentina	1982
Wolsung	629	Korea	1982
Cernavoda 1	600	Romania	1988
Cernavoda 2	600	Romania	1989

APPENDIX 2

FORECAST YEAR IN SERVICE - UNIT - MWE

	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12
SCENARIO 1 - HIGH GROWTH																						
MARITIMES	600					600			600			600			950		950					
QUEBEC		850			850	850	850	850	850	850	850	850	850	850	850	850	850	850	850	850	850	850
ONTARIO			850	850	850	850	850	850	850	850	850	850	850	850	850	850	850	850	850	850	850	850
												850			850			850			850	
WEST						600			600				600		850	850		850	850			
EXPORT		600		600	600	600	600	600	600	600	950	950	950	950	950	950	950	950	950	950	950	950
						600	600	600	600	600									950	950	950	950
SCENARIO 2 - MEDIUM GROWTH																						
MARITIMES	600								600								600					
QUEBEC		850			850		850		850	850	850	850	850	850	850	850	850	850	850	850	850	850
ONTARIO				850	850	850	850	850	850		850	850	850	850	850	850	850	850	850	850	850	850
WEST							600				600					950			950			
EXPORT					600	600		600	600		950		950		950		950		950	950	950	950
SCENARIO 3 - LOW GROWTH																						
MARITIMES	600																					
QUEBEC									850		850		850		850							
ONTARIO				850	850		850	850				850	850		850	850						
WEST											600											
EXPORT						600					950		950			950		950		950	950	

APPENDIX 3

CANDU FUTURES - FORECAST MWe IN SERVICE

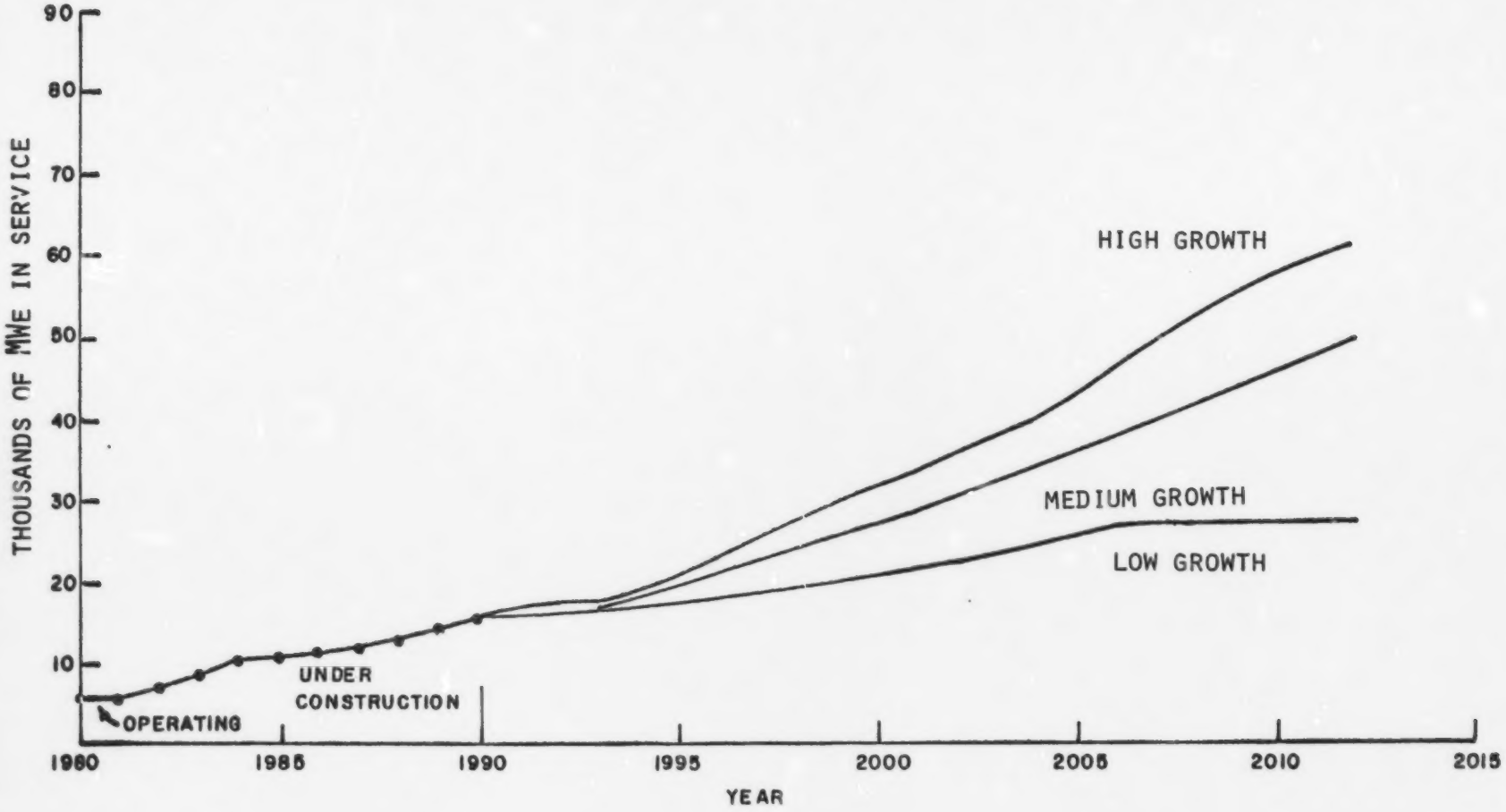

FIGURE 5 CANDU FUTURES – FORECAST MWe IN SERVICE IN CANADA

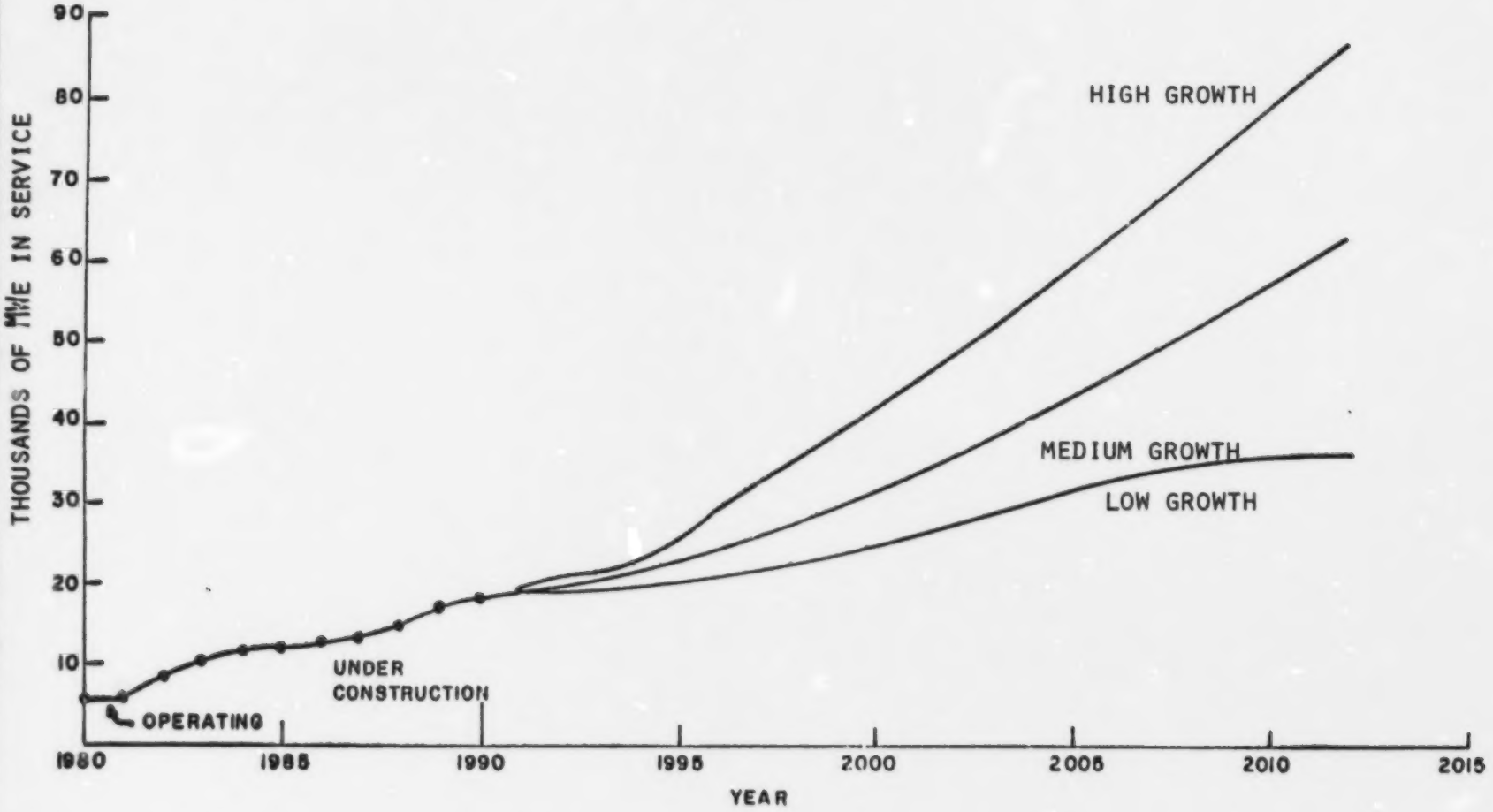

FIGURE 6 CANDU FUTURES - TOTAL FORECAST MWe IN SERVICE

APPENDIX 4

EXAMPLE OF ECONOMIC AND LABOUR MODEL

Productivity
Factor 3%

TABLE A5-14

1978 12 07

DIRECT EMPLOYMENT IN MANUFACTURING SECTORS IN ONTARIO IN MAN-YEARS
FOR EACH $1 MILLION OF CONSTANT (1977) EXPENDITURE BY ONTARIO HYDRO ON P.M.&C.

Year 1st Unit In Service	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1976	9.66	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1977	9.05	9.38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1978	10.62	8.78	9.11	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1979	8.69	10.31	8.53	8.84	-	-	-	-	-	-	-	-	-	-	-	-	-
1980	9.25	8.44	10.01	8.20	8.58	-	-	-	-	-	-	-	-	-	-	-	-
1981	8.75	8.98	8.19	9.72	8.04	8.33	-	-	-	-	-	-	-	-	-	-	-
1982	11.74	8.49	8.72	7.95	9.44	7.81	8.09	-	-	-	-	-	-	-	-	-	-
1983	11.51	11.40	8.25	8.47	7.72	9.16	7.50	7.85	-	-	-	-	-	-	-	-	-
1984	11.85	11.18	11.06	8.01	8.22	7.50	8.90	7.36	7.63	-	-	-	-	-	-	-	-
1985	-	11.51	10.85	10.74	7.77	7.98	7.20	8.64	7.14	7.40	-	-	-	-	-	-	-
1986	-	-	11.17	10.54	10.43	7.55	7.75	7.07	8.38	6.93	7.19	-	-	-	-	-	-
1987	-	-	-	10.85	10.23	10.13	7.33	7.52	6.86	8.14	6.73	6.90	-	-	-	-	-
1988	-	-	-	-	10.53	9.93	9.03	7.11	7.30	6.66	7.90	6.54	6.78	-	-	-	-
1989	-	-	-	-	-	10.23	9.64	9.54	6.91	7.09	6.47	7.67	6.35	6.50	-	-	-
1990	-	-	-	-	-	-	10.87	9.36	9.27	6.70	6.80	6.20	7.45	6.16	6.39	-	-
1991	-	-	-	-	-	-	-	9.64	9.09	9.00	6.51	6.60	6.09	7.23	5.98	6.20	-
1992	-	-	-	-	-	-	-	-	9.36	8.82	8.73	5.32	6.49	5.92	7.02	5.81	6.02
1993	-	-	-	-	-	-	-	-	-	9.09	8.57	8.40	6.14	6.30	5.74	6.82	5.64
1994	-	-	-	-	-	-	-	-	-	-	8.82	8.32	8.23	5.96	6.12	5.50	6.02
1995	-	-	-	-	-	-	-	-	-	-	-	8.56	8.00	7.99	5.78	5.94	5.41
1996	-	-	-	-	-	-	-	-	-	-	-	-	8.31	7.84	7.76	5.61	5.77
1997	-	-	-	-	-	-	-	-	-	-	-	-	-	8.07	7.61	7.53	5.45
1998	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.04	7.39	7.31
1999	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.61	7.18
2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.39

APPENDIX 4

October 11, 1979

I/S First Unit 01 Oct 83
I/S Second Unit 01 Jul 84
I/S Third Unit 01 Apr 86

TABLE 'A'

Distribution of Total Construction Capital Costs

($ Million) As Spent

BRUCE GS 'B' PROJECT ONTARIO HYDRO	Prior to -8	YEAR OF EXPENDITURE -8 1979	-7 1980	-6 1981	-5 1982	-4 1983	-3 1984	-2 1985	-1 1986	Last Unit In-Service 01 Jan 87	+1 1987	TOTAL	
1. LABOUR													
Direct Labour	89	29	49	50	53	45	34	22	7		2	320	- Hydro Trades
Major & Service Labour	9	6	9	10	12	14	16	10	3		-	89	- Contractor Trades
Camp/Catering Labour	1	1	2	2	2	2	1	1	1		-	13	- Camp Staff & Trades
Non Manual Labour	7	8	10	13	14	15	15	13	7		2	104	- Field Hydro/Contractor Staff
Sub-Total Labour	46	44	70	75	81	76	66	46	18		4	526	
2. DIRECT MATERIALS													
Major Equipment	43	125	123	190	187	135	7	8	7		1	826	
Bulk Material	50	63	77	68	57	21	3	2	1		-	342	
Sub-Total Materials	93	188	200	258	244	156	10	10	8		1	1,168	
3. SUB-CONTRACT MATERIALS													
Major and Service	7	19	18	22	14	11	4	7	10		-	112	- Materials supplied by contractors & Expendables
Camp/Catering	1	-	-	-	-	-	-	-	-		-	1	
Sub-Total S.C. Material	8	19	18	22	14	11	4	7	10		-	113	
4. HOME OFFICE	58	36	39	29	24	22	17	9	8		6	248	
5. DISTRIBUTABLES	24	32	75	123	173	239	160	109	61		8	1,010	- Interest, Corporate Overhead, Insurance, P.R., Contingencies
TOTAL DESIGN & CONSTRUCTION COSTS (Commissioning & Heavy Water costs excluded)	229	319	402	507	536	504	257	181	111		19	3,065	

APPENDIX 4

TABLE 'D'

October 11, 1979

DISTRIBUTION OF CAPITAL EXPENDITURES FOR EQUIPMENT & MATERIALS By Major Categories

I/S First Unit 01 Oct 83
I/S Second Unit 01 Jul 84
I/S Third Unit 01 Apr 86

($ MILLION)

BRUCE GS 'B' PROJECT
ONTARIO HYDRO

	Prior to -8	-8 1979	-7 1980	-6 1981	-5 1982	-4 1983	-3 1984	-2 1985	-1 1986	Last Unit In-Service 01 Jan 87	+1 1987	TOTAL
Bulk Material												
Unassigned	1	(1)	-	-	-	-	-	-	-		-	-
Site & Improvements	4	-	-	-	-	-	-	-	-		-	4
Reactor Buildings	7	6	10	11	6	2	-	-	-		-	42
Powerhouse	4	11	16	12	7	1	-	-	-		-	51
C.W. Structures	3	2	3	2	-	-	-	-	-		-	10
Vacuum Building & Prds.	2	2	2	1	-	-	-	-	-		-	7
Aux. Structures	2	1	1	-	-	-	-	-	-		-	4
Reactor Fuelling	12	23	12	7	7	7	-	-	-		-	68
Reactors & Boilers (AECL)	10	5	12	9	10	2	-	-	1		-	49
Reactors & Boilers (Hydro)	-	-	1	1	3	-	-	-	-		-	5
Turbine Generator & Auxs.	-	1	1	4	3	2	-	-	-		-	11
Electrical Power	1	3	5	6	6	1	1	1	-		-	24
Instrumentation	2	9	12	11	11	4	1	1	-		-	51
Circulating Cooling Water	2	-	-	1	2	1	-	-	-		-	6
Common Processes & Services	-	1	2	3	2	1	1	-	-		-	10
TOTAL	50	63	77	68	57	21	3	2	1		-	342
Major Equipment												
Unassigned	1	(1)	-	-	-	-	-	-	-		-	Nil
Reactors & Boilers (AECL)	40	53	64	70	54	27	1	7	7		1	324
Reactors & Boilers (Hydro)	-	1	2	4	11	1	-	-	-		-	19
Turbine Gen. & Auxs.	-	50	15	80	94	93	4	-	-		-	344
Electric Power	1	16	23	18	18	9	-	-	-		-	85
Instrumentation	-	1	2	2	2	1	-	-	-		-	8
Circulating Water Systems	-	2	8	5	4	3	-	-	-		-	22
Common Processes & Servs.	1	3	9	3	4	1	2	1	-		-	24
TOTAL	43	125	123	190	187	135	7	8	7		1	826
Equipment & Material TOTAL FOR DIRECTS	93	188	200	258	244	156	10	10	8		1	1,168

October 11, '9

I/S First Unit 01 Oct
I/S Second Unit 01 Jan
I/S Third Unit 01 Apr

TABLE 'C'

Distribution of Project Direct Labour Demand From Owner, Manager/Engineer, Contractor & Sub'n (inc. expl. & map, etc...)

BRUCE GS 'B' PROJECT

ONTARIO HYDRO

LABOUR SKILL CATEGORY	Prior to -8	(MAN YEARS) 08 1979	-7 1980	-6 1981	-5 1982	-4 1983	-3 1984	-2 1985	-1 1986	Last Unit In-Service 01 Jan 87	+1 1987	TOTAL
Engineering												
Management - Head Office	109	50	50	49	40	33	32	22	14		12	411
Engineering - Design (incl. Techs. & Clerical)	644	366	355	266	209	150	119	53	39		34	2,243
Draughtsman	457	254	211	124	92	71	50	15	12		10	1,296
Sub-Total Engineering	1,210	670	616	439	341	262	201	90	65		56	3,950
Trades												
*Machinists	19	12	7	4	5	5	5	2	1		-	60
Sheet Metal Workers	9	11	30	39	42	34	26	16	5		-	212
Welders & Pipefitters	66	97	488	533	525	385	331	143	51		5	2,624
Boiler Makers	50	76	102	89	71	58	46	29	8		2	531
Engine & Related Ass'y Iron Workers & Rodmen	119	168	208	214	169	137	89	51	14		16	1,185
Motor Vehicle Mechanics Heavy Equipment Operators Labourers & Helpers	498	361	398	274	245	225	130	115	22		9	2,285
Electricians	75	104	264	409	449	349	245	150	26		1	2,072
Carpenters	404	351	397	255	221	200	136	77	77		3	2,121
Masons	11	22	35	25	17	11	9	1	-		-	131
Plasterers, Painters	10	22	27	34	42	45	37	22	5		2	246
Insulators	9	4	6	18	49	62	51	45	27		1	272
Teamsters	134	73	78	75	81	81	77	66	1		-	666
Crane Operators **Operating Engineers	144	93	95	83	80	77	65	33	9		1	680
Others	73	79	87	88	86	84	66	56	37		6	662
Sub-Total Trades	1,621	1,473	2,222	2,140	2,082	1,753	1,321	806	283		46	13,747

*Incl. Motor Veh. Mech.

**Incl. Crane & Heavy Equip. Oper.

APPENDIX 4

October 11, 1979

I/S First Unit 01 Oct 83
I/S Second Unit 01 Jul 84
I/S Third Unit 01 Apr 85

TABLE 'C'

Distribution of Project Direct Labour Demand From Owner, Manager/Engineer, Contractor & Sub's (inc. expl. & map, etc...)

BRUCE GS 'B' PROJECT

ONTARIO HYDRO

LABOUR SKILL CATEGORY	Prior to -8	(MAN YEARS) -8 1979	-7 1980	-6 1981	-5 1982	-4 1983	-3 1984	-2 1985	-1 1986	Last Unit In-Service 01 Jan 87	+1 1987	TOTAL
Field Staff												
Management	3	4	3	3	3	3	3	3	1		-	26
Superintendents & General Foreman	55	42	50	53	52	48	43	31	19		3	396
Engineers	33	37	46	46	45	43	39	34	17		2	342
Engineering Technicians	140	134	182	227	230	239	199	165	79		12	1,615
Clerical (Accounting)	21	34	32	32	33	33	30	24	12		5	256
Others (Accident Prevention, Personnel & Security)	31	35	44	45	39	41	37	38	24		12	346
Contractors Staff	20	22	31	32	35	35	37	23	6		1	242
Sub-Total	303	308	388	438	445	442	388	318	158		35	3,223
GRAND TOTAL MAN YEARS	3,134	2,451	3,226	3,017	2,068	2,457	1,910	1,214	506		137	20,920

APPENDIX 5

SCENARIO 1: High Growth

CAPITAL Expenditures and Employment for Domestic Program, Export Program and Combined Program

CANADIAN NUCLEAR ASSOCIATION

SCENARIO 1: High Growth

CAPITAL EXPENDITURES ($'000,000)

DOMESTIC PROGRAM

	YEAR																						
	1980	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000	01	TOTAL
MAJOR EQUIPMENT	305	283	231	230	231	295	310	302	340	387	489	529	552	654	699	647	675	769	759	790	872	885	11233
BULK MATERIALS	181	164	133	128	137	164	184	182	194	215	269	315	332	368	413	382	379	438	450	448	509	518	6504
LABOUR	211	210	180	167	156	191	208	219	240	254	313	351	372	427	494	403	464	527	543	529	600	634	7774
ENGINEERING	139	127	110	107	112	121	124	150	195	194	213	228	246	256	309	288	274	356	357	315	390	373	4983
HEAVY WATER	384	450	288	186	209	287	295	358	358	359	358	377	584	661	737	847	716	710	847	792	793	1026	11630
HALF FUEL CHARGE	16	19	11	4	0	0	5	11	11	15	15	11	11	16	31	32	22	30	30	22	31	36	379
DISTRIBUTABLES	503	483	348	284	260	368	406	422	484	528	581	616	726	860	978	1010	953	1037	1089	1058	1177	1250	15421
TOTAL	1739	1735	1301	1106	1105	1426	1532	1644	1822	1952	2238	2427	2823	3242	3661	3689	3483	3875	4075	3954	4372	4722	57923
CANADIAN CONTENT	1606	1670	1250	1053	1052	1359	1462	1574	1744	1863	2125	2305	2696	3091	3501	3538	3329	3699	3898	3773	4172	4516	55275
% CANADIAN CONTENT	92	96	96	95	95	95	95	95	95	95	94	94	95	95	95	95	95	95	95	95	95	95	95
INSTALLED CAP. (1000 MW)	5.4	5.4	7.3	9.2	10.4	10.4	11.1	11.7	12.6	13.5	14.3	15.9	16.7	17.6	18.5	20.3	23.5	25.3	27.0	30.1	31.8	33.6	

CANADIAN NUCLEAR ASSOCIATION

SCENARIO 1: High Growth

CANADIAN EMPLOYMENT - MANYEARS ('000)

DOMESTIC PROGRAM

	YEAR																						
	1980	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000	01	TOTAL
MANUFACTURING	4.9	4.6	3.7	3.6	3.8	4.7	5.1	4.9	5.4	6.1	7.7	8.6	9.0	10.4	11.4	10.5	10.7	12.3	12.3	12.6	14.1	14.3	160.9
CONSTRUCTION	3.7	3.7	3.2	2.9	2.7	3.4	3.7	3.8	4.2	4.5	5.5	6.2	6.5	7.5	8.7	8.5	8.1	9.2	9.5	9.3	10.5	11.1	136.4
ENGINEERING	1.9	1.7	1.5	1.5	1.5	1.7	1.7	2.1	2.7	2.7	2.9	3.1	3.4	3.5	4.3	4.0	3.8	4.9	4.9	4.3	5.4	5.1	69.8
HEAVY LATER	2.2	2.5	1.6	1.0	1.2	1.6	1.7	2.0	2.0	2.0	2.0	2.1	3.3	3.7	4.1	4.8	4.0	4.0	4.8	4.5	4.5	5.8	65.4
HALF FUEL CHARGE	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.3	0.2	0.3	0.3	0.2	0.3	0.3	3.2
DIRECT	12.9	12.7	10.1	9.1	9.2	11.3	12.1	13.0	14.5	15.4	18.3	20.1	22.3	25.3	28.7	28.0	26.9	30.8	31.8	30.9	34.7	36.6	454.7
INDIRECT	23.3	22.9	18.3	16.5	16.7	20.5	21.9	23.5	26.2	27.9	33.1	36.5	40.4	45.8	52.0	50.6	48.7	55.7	57.6	55.9	62.9	66.3	823.0
TOTAL	36.1	35.6	28.5	25.7	25.9	31.8	34.0	36.4	40.6	43.3	51.4	56.6	62.8	71.0	80.7	78.6	75.5	86.4	89.3	86.8	97.6	103.0	1277.7

CANADIAN NUCLEAR ASSOCIATION

SCENARIO 1: High Growth

CAPITAL EXPENDITURES ($'000,000)

EXPORT PROGRAM

	YEAR																					
	1980	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000	01	TOTAL
MAJOR EQUIPMENT	59	24	22	89	146	148	163	163	152	209	306	409	464	527	553	544	504	479	456	437	423	427	6704
BULK MATERIALS	32	13	10	52	94	88	84	94	87	115	171	235	275	310	325	324	299	280	267	256	248	250	3909
LABOUR	52	24	10	55	107	108	105	114	105	131	192	273	316	375	400	407	380	357	337	321	308	311	4798
ENGINEERING	19	10	20	50	73	76	71	85	92	122	166	210	229	247	245	240	223	212	206	202	195	205	3198
HEAVY WATER	113	56	0	0	56	112	113	113	112	56	113	168	225	337	394	450	450	422	395	366	338	338	4727
HALF FUEL CHARGE	8	4	0	0	0	0.	4	8	4	0	4	4	4	8	12	16	16	16	16	14	12	12	162
DISTRIBUTABLES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	283	131	62	246	476	532	540	577	552	633	952	1299	1513	1804	1929	1981	1872	1766	1677	1596	1524	1543	23488
CANADIAN CONTENT	173	83	28	94	207	267	279	292	286	285	443	598	705	873	951	1000	961	909	863	817	773	783	11670
% CANADIAN CONTENT	61	63	45	38	43	50	51	50	51	45	46	46	46	48	49	50	51	51	51	51	50	50	49
INSTALLED CAP. (1000 MW)	0.5	1.1	1.8	1.8	1.8	1.8	1.8	1.8	2.4	3.0	3.0	3.0	3.7	3.7	4.3	4.9	6.2	7.4	8.7	10.0	11.2	12.2	

CANADIAN NUCLEAR ASSOCIATION

SCENARIO 1: High Growth

CANADIAN EMPLOYMENT - MANYEARS ('000)

EXPORT PROGRAM

	YEAR																						
	1980	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000	01	TOTAL
MANUFACTURING	0.4	0.2	0.2	0.7	1.1	1.1	1.2	1.2	1.1	1.6	2.3	3.1	3.5	4.0	4.2	4.1	3.8	3.6	3.4	3.3	3.2	3.2	50.4
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.2	0.1	0.2	0.5	0.8	0.8	0.8	1.0	1.0	1.4	1.8	2.3	2.5	2.7	2.7	2.6	2.4	2.3	2.3	2.2	2.2	2.3	35.3
HEAVY WATER	0.6	0.3	0.0	0.0	0.3	0.6	0.6	0.6	0.6	0.3	0.6	0.9	1.3	1.9	2.2	2.5	2.5	2.4	2.2	2.1	1.9	1.9	26.6
HALF FUEL CHARGE	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.4
DIRECT	1.4	0.6	0.4	1.2	2.2	2.6	2.7	2.9	2.8	3.2	4.8	6.4	7.3	8.6	9.2	9.4	8.9	8.4	8.1	7.7	7.3	7.5	113.7
INDIRECT	2.4	1.2	0.7	2.2	4.0	4.7	4.9	5.2	5.1	5.8	8.7	11.5	13.3	15.6	16.6	17.0	16.1	15.3	14.6	13.9	13.3	13.5	205.8
TOTAL	3.8	1.8	1.0	3.4	6.3	7.3	7.6	8.1	8.0	9.1	13.5	17.9	20.6	24.3	25.8	26.4	25.0	23.7	22.6	21.6	20.6	21.0	319.4

CANADIAN NUCLEAR ASSOCIATION

SCENARIO 1: High Growth

CAPITAL EXPENDITURES ($'000,000)

COMBINED PROGRAM

	YEAR																						
	1980	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000	01	TOTAL
MAJOR EQUIPMENT	364	307	253	319	377	443	473	465	492	596	795	938	1016	1181	1252	1191	1179	1248	1215	1227	1295	1312	17937
BULK MATERIALS	213	177	143	180	231	252	268	276	281	330	440	550	607	678	738	706	678	718	717	704	757	768	10413
LABOUR	263	234	190	222	263	299	313	333	345	385	505	624	688	802	894	890	844	884	880	850	908	945	12562
ENGINEERING	158	137	130	157	185	197	195	235	287	316	379	438	475	503	554	528	497	568	563	517	585	578	8181
HEAVY WATER	497	506	288	186	265	399	408	471	470	415	471	545	809	998	1131	1297	1166	1140	1242	1158	1131	1364	16357
HALF FUEL CHARGE	24	23	11	4	0	0	9	19	15	15	19	15	15	24	43	48	38	46	46	36	43	48	541
DISTRIBUTABLES	503	483	348	284	260	368	406	422	484	528	581	616	726	860	978	1010	953	1037	1089	1058	1177	1250	15421
TOTAL	2022	1866	1363	1352	1581	1958	2072	2221	2374	2585	3190	3726	4336	5046	5590	5670	5355	5641	5752	5550	5896	6265	81411
CANADIAN CONTENT	1779	1753	1278	1147	1259	1626	1741	1866	2030	2148	2568	2903	3401	3964	4452	4538	4290	4608	4761	4590	4945	5299	66945
% CANADIAN CONTENT	87	93	93	84	79	83	83	84	85	83	80	77	78	78	79	80	80	81	82	82	83	84	82
INSTALLED CAP. (1000 MW)	5.9	6.5	9.1	10.9	12.2	12.2	12.8	13.5	15.0	16.5	17.4	18.9	20.4	21.3	22.8	25.2	29.7	32.7	35.7	40.0	43.0	45.7	

CANADIAN NUCLEAR ASSOCIATION

SCENARIO 1 : High Growth

CANADIAN EMPLOYMENT - MANYEARS ('000)

COMBINED PROGRAM

	YEAR																						
	1980	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000	01	TOTAL
MANUFACTURING	5.4	4.7	3.9	4.3	4.9	5.8	6.3	6.2	6.6	7.7	10.0	11.7	12.5	14.4	15.5	14.6	14.5	15.9	15.8	15.9	17.3	17.5	231.3
CONSTRUCTION	3.7	3.7	3.2	2.9	2.7	3.4	3.7	3.8	4.2	4.5	5.5	6.2	6.5	7.5	8.7	8.5	8.1	9.2	9.5	9.3	10.5	11.1	136.4
ENGINEERING	2.1	1.9	1.7	2.0	2.4	2.5	2.5	3.0	3.7	4.0	4.8	5.5	5.9	6.3	7.0	6.6	6.2	7.2	7.2	6.6	7.5	7.4	104.1
HEAVY WATER	2.8	2.8	1.6	1.0	1.5	2.2	2.3	2.6	2.6	2.3	2.6	3.1	4.5	5.6	6.4	7.3	6.6	6.4	7.0	6.5	6.4	7.7	91.9
HALF FUEL CHARGE	0.2	0.2	0.1	0.0	0.0	0.0	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.2	0.4	0.4	0.3	0.4	0.4	0.3	0.4	0.4	4.6
DIRECT	14.2	13.3	10.5	10.3	11.4	13.9	14.8	15.8	17.3	18.6	23.1	26.5	29.7	33.9	37.9	37.4	35.8	39.2	39.9	38.6	42.1	44.1	369.4
INDIRECT	25.7	24.1	19.0	18.7	20.7	25.2	26.8	28.7	31.3	33.7	41.8	48.0	53.7	61.4	68.6	67.6	64.8	71.0	72.1	69.8	76.2	79.9	1029.7
TOTAL	39.9	37.4	29.5	29.0	32.2	39.1	41.7	44.5	48.6	52.4	64.9	74.5	83.4	95.3	106.5	105.0	100.6	110.2	112.0	108.4	118.2	124.0	1597.1

APPENDIX 6

SCENARIO 2: Medium Growth

CAPITAL Expenditures and Employment for Domestic Program, Export Program and Combined Program

CANADIAN NUCLEAR ASSOCIATION

SCENARIO 2: Medium Growth

CAPITAL EXPENDITURES ($'000,000)

DOMESTIC PROGRAM

	YEAR																					
	1980	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000	01	TOTAL
MAJOR EQUIPMENT	305	283	231	230	231	276	291	261	252	299	307	391	410	461	519	512	560	500	529	517	602	647	8574
BULK MATERIALS	181	164	133	128	137	154	174	161	149	160	177	212	244	274	290	301	317	303	301	301	336	372	4966
LABOUR	211	210	160	167	156	179	198	199	185	200	210	244	287	319	359	355	397	358	381	348	407	443	5918
ENGINEERING	139	127	110	107	112	87	112	138	110	149	141	180	166	210	228	224	231	207	219	227	260	274	3757
HEAVY WATER	384	450	288	184	209	267	295	326	328	284	282	391	303	509	509	586	565	566	640	586	668	604	9190
HALF FUEL CHARGE	16	19	11	4	0	0	5	11	11	15	15	6	5	16	17	20	21	20	21	20	24	22	301
DISTRIBUTABLES	503	483	348	284	260	358	389	394	409	433	433	415	490	619	706	711	787	719	805	766	840	822	11973
TOTAL	1739	1735	1301	1106	1105	1341	1464	1522	1468	1542	1570	1739	1875	2408	2619	2689	2878	2668	2896	2765	3133	3181	44744
CANADIAN CONTENT	1606	1670	1250	1053	1052	1278	1399	1461	1410	1474	1498	1652	1781	2300	2504	2569	2751	2551	2775	2645	2995	3032	42705
% CANADIAN CONTENT	92	96	96	95	95	95	95	95	96	95	95	94	94	95	95	95	95	95	95	95	95	95	95
INSTALLED CAP. (1000 MW)	5.4	5.4	7.3	9.2	10.4	10.4	11.1	11.7	12.6	13.5	14.3	15.9	16.7	16.7	17.6	19.4	20.3	22.6	23.5	25.9	26.8	29.2	

CANADIAN NUCLEAR ASSOCIATION

SCENARIO 2: Medium Growth

CANADIAN EMPLOYMENT - MANYEARS ('000)

DOMESTIC PROGRAM

	YEAR																					
	1980	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000	01	TOTAL
MANUFACTURING	4.9	4.6	3.7	3.6	3.8	4.4	4.8	4.3	4.0	4.7	4.9	6.0	6.7	7.5	8.2	8.3	9.0	8.2	8.5	8.3	9.6	10.4	139.3
CONSTRUCTION	3.7	3.7	3.2	2.9	2.7	3.1	3.5	3.5	3.2	3.5	3.8	4.3	4.5	5.6	6.3	6.2	7.0	6.2	6.7	6.1	7.2	7.7	104.7
ENGINEERING	1.9	1.7	1.5	1.5	1.5	1.2	1.5	1.9	1.5	2.1	1.9	2.5	2.3	2.9	3.1	3.1	3.2	2.9	3.0	3.1	3.6	3.8	51.8
HEAVY WATER	2.2	2.5	1.6	1.0	1.2	1.6	1.7	2.0	2.0	1.6	1.6	1.7	1.7	2.9	2.9	3.2	3.2	3.2	3.6	3.3	3.7	3.4	51.6
HALF FUEL CHARGE	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	2.6
DIRECT	12.9	12.7	10.1	9.1	9.2	10.3	11.5	11.8	10.9	12.0	12.4	14.6	15.2	19.0	20.6	20.9	22.5	20.6	22.0	21.0	24.3	25.5	349.0
INDIRECT	23.3	22.9	18.3	16.5	16.7	18.7	20.8	21.4	19.7	21.7	22.4	26.3	27.6	34.4	37.3	37.9	40.7	37.3	39.7	38.1	43.9	46.1	631.7
TOTAL	36.1	35.6	28.5	25.7	25.9	29.0	32.3	33.2	30.6	33.7	34.7	40.9	42.8	53.3	58.0	58.9	63.1	57.9	61.7	59.1	68.1	71.6	980.8

CANADIAN NUCLEAR ASSOCIATION

SCENARIO 2: Medium Growth

CAPITAL EXPENDITURES ($'000,000)

EXPORT PROGRAM

	YEAR																						
	1980	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000	01	TOTAL
MAJOR EQUIPMENT	59	24	22	89	143	133	101	75	45	74	135	135	159	212	197	198	203	211	210	203	220	203	3052
BULK MATERIALS	32	13	10	52	92	81	55	41	24	34	75	89	92	118	122	113	120	123	125	118	130	118	1777
LABOUR	52	24	10	55	105	102	73	59	34	36	81	96	111	146	149	145	144	153	156	141	167	141	2180
ENGINEERING	19	10	20	30	66	57	37	35	38	46	65	77	78	89	97	91	93	97	100	92	103	92	1452
HEAVY WATER	113	56	0	0	56	112	113	113	56	0	0	56	112	113	169	168	113	197	141	169	169	169	2195
HALF FUEL CHARGE	8	4	0	0	0	0	4	8	4	0	0	0	0	4	8	4	4	8	4	6	6	6	78
DISTRIBUTABLES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	283	131	62	246	462	485	383	331	202	190	356	453	552	682	742	719	677	789	736	729	795	729	10734
CANADIAN CONTENT	173	83	28	94	199	243	212	197	119	83	138	203	274	321	380	368	320	415	358	376	397	376	5357
% CANADIAN CONTENT	61	63	45	38	43	50	55	59	58	43	38	44	49	47	51	51	47	52	48	51	49	51	49
INSTALLED CAP. (1000 MW)	0.5	1.1	1.8	1.8	1.8	1.8	1.8	1.8	2.4	3.0	3.0	3.0	3.0	3.0	3.0	3.7	4.3	4.3	4.9	5.5	5.5	6.5	

CANADIAN NUCLEAR ASSOCIATION

SCENARIO 2: Medium Growth

CANADIAN EMPLOYMENT - MANYEARS ('000)

EXPORT PROGRAM

	YEAR																					
	1980	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000	01	TOTAL
MANUFACTURING	0.4	0.2	0.2	0.7	1.1	1.0	0.8	0.6	0.3	0.5	1.0	1.0	1.2	1.6	1.5	1.5	1.5	1.6	1.6	1.5	1.7	1.5	23.0
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.2	0.1	0.2	0.5	0.7	0.6	0.4	0.4	0.4	0.5	0.7	0.9	0.9	1.0	1.1	1.0	1.0	1.1	1.1	1.0	1.1	1.0	16.0
HEAVY WATER	0.6	0.3	0.0	0.0	0.3	0.6	0.6	0.6	0.3	0.0	0.0	0.3	0.6	0.6	0.9	0.9	0.6	1.1	0.8	0.9	0.9	0.9	12.3
HALF FUEL CHARGE	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.7
DIRECT	1.4	0.6	0.4	1.2	2.1	2.3	1.9	1.7	1.1	1.1	1.7	2.2	2.7	3.2	3.4	3.5	3.2	3.8	3.5	3.5	3.8	3.5	52.0
INDIRECT	2.4	1.2	0.7	2.2	3.8	4.1	3.4	3.0	2.0	1.9	3.2	4.0	4.8	5.9	6.5	6.2	5.8	6.9	6.4	6.4	6.9	6.4	94.1
TOTAL	3.8	1.8	1.0	3.4	6.0	6.4	5.2	4.7	3.1	3.0	4.9	6.1	7.5	9.1	10.1	9.7	9.1	10.8	9.9	9.9	10.7	9.9	146.1

CANADIAN NUCLEAR ASSOCIATION

SCENARIO 2: Medium Growth

CAPITAL EXPENDITURES ($'000,000)

COMBINED PROGRAM

	YEAR																						
	1980	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000	01	TOTAL
MAJOR EQUIPMENT	364	307	253	319	374	409	392	336	298	373	442	516	569	673	707	710	763	711	739	720	822	850	11446
BULK MATERIALS	213	177	143	180	229	235	229	202	167	196	252	301	336	392	412	414	437	426	426	419	466	490	6743
LABOUR	263	234	190	222	261	281	271	258	219	236	296	340	368	465	508	500	541	507	537	489	576	581	8144
ENGINEERING	158	137	130	157	178	144	149	173	148	195	206	257	244	299	325	315	324	304	319	319	363	366	5209
HEAVY WATER	497	506	288	186	265	399	408	471	414	284	282	357	415	622	678	734	678	763	781	755	829	773	11385
HALF FUEL CHARGE	24	23	11	4	0	0	9	19	15	15	15	6	5	20	25	24	25	28	25	26	32	28	379
DISTRIBUTABLES	503	483	348	284	260	358	389	394	409	433	433	415	490	619	706	711	787	718	805	766	840	822	11973
TOTAL	2022	1866	1363	1352	1567	1826	1847	1853	1670	1732	1926	2192	2427	3090	3361	3408	3555	3457	3632	3494	3928	3910	55478
CANADIAN CONTENT	1779	1753	1278	1147	1251	1521	1611	1658	1539	1557	1636	1855	2055	2621	2884	2937	3071	2966	3133	3021	3392	3408	48062
% CANADIAN CONTENT	87	93	93	84	79	84	87	89	91	89	84	84	84	84	85	86	86	85	86	86	86	87	86
INSTALLED CAP. (1000 MW)	5.9	6.5	9.1	10.9	12.2	12.2	12.8	13.5	15.0	16.5	17.4	18.9	19.8	19.8	20.6	23.0	24.5	26.9	28.4	31.5	32.3	35.7	

CANADIAN NUCLEAR ASSOCIATION

SCENARIO 2: Medium Growth

CANADIAN EMPLOYMENT - MANYEARS ('000)

COMBINED PROGRAM

	YEAR																					
	1980	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000	01	TOTAL
MANUFACTURING	5.4	4.7	3.9	4.3	4.8	5.4	5.5	4.9	4.4	5.2	5.9	7.1	7.9	9.1	9.7	9.8	10.5	9.8	10.1	9.9	11.2	11.9	161.2
CONSTRUCTION	3.7	3.7	3.2	2.9	2.7	3.1	3.5	3.5	3.2	3.5	3.8	4.3	4.5	5.6	6.3	6.2	7.0	6.2	6.7	6.1	7.2	7.7	104.7
ENGINEERING	2.1	1.9	1.7	2.0	2.3	1.8	2.0	2.3	1.9	2.6	2.7	3.3	3.1	3.9	4.2	4.1	4.2	3.9	4.1	4.1	4.7	4.8	67.9
HEAVY WATER	2.8	2.8	1.6	1.0	1.5	2.2	2.3	2.6	2.3	1.6	1.6	2.0	2.3	3.5	3.8	4.1	3.8	4.3	4.4	4.2	4.7	4.3	64.0
HALF FUEL CHARGE	0.2	0.2	0.1	0.0	0.0	0.0	0.1	0.2	0.1	0.1	0.1	0.1	0.0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2	3.2
DIRECT	14.2	13.3	10.5	10.3	11.3	12.6	13.3	13.5	12.0	13.0	14.1	16.7	17.9	22.2	24.2	24.4	25.7	24.4	25.5	24.6	28.1	29.0	401.0
INDIRECT	25.7	24.1	19.0	18.7	20.5	22.8	24.2	24.4	21.7	23.6	25.5	30.3	32.4	40.2	43.8	44.2	46.5	44.2	46.1	44.5	50.8	52.5	725.8
TOTAL	39.9	37.4	29.5	29.0	31.9	35.5	37.5	37.9	33.7	36.7	39.6	47.0	50.3	62.4	68.1	68.6	72.2	68.7	71.6	69.1	78.8	81.5	1126.8

APPENDIX 7

SCENARIO 3: Low Growth

CAPITAL Expenditures and Employment for Domestic Program

Export Program and Combined Program

CANADIAN NUCLEAR ASSOCIATION

SCENARIO 3: Low Growth

CAPITAL EXPENDITURES ($'000,000)

DOMESTIC PROGRAM

	YEAR																					
	1980	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000	01	TOTAL
MAJOR EQUIPMENT	305	283	231	230	212	257	250	195	176	180	167	154	162	186	195	250	274	287	287	267	271	179	4997
BULK MATERIALS	181	164	133	128	127	144	153	122	95	99	96	89	94	110	110	140	158	173	166	161	152	119	2913
LABOUR	211	210	180	167	144	169	178	158	133	134	132	94	99	138	136	154	185	207	205	178	191	152	3556
ENGINEERING	139	127	110	107	78	75	100	94	55	78	83	73	45	85	98	139	96	144	113	74	67	46	2025
HEAVY WATER	384	450	288	186	209	287	295	358	283	208	206	151	152	226	226	227	227	282	282	359	359	377	6022
HALF FUEL CHARGE	16	19	11	4	0	0	5	11	11	15	10	0	5	11	6	5	11	11	6	9	15	16	197
DISTRIBUTABLES	503	483	348	284	250	341	361	342	330	296	255	176	225	273	271	290	354	364	396	403	453	343	7341
TOTAL	1739	1735	1301	1106	1020	1273	1342	1280	1083	1010	949	737	782	1029	1042	1205	1303	1468	1455	1451	1508	1232	27050
CANADIAN CONTENT	1606	1670	1250	1053	971	1215	1286	1234	1043	969	910	702	744	986	998	1147	1240	1402	1389	1389	1446	1189	25838
% CANADIAN CONTENT	92	96	96	95	95	95	95	96	96	95	95	95	95	95	95	95	95	95	95	95	95	96	95
INSTALLED CAP. (1000 MW)	5.4	5.4	7.3	9.2	10.4	10.4	11.1	11.7	12.6	13.5	14.3	15.9	15.9	15.9	16.7	17.6	17.6	18.5	19.4	20.3	20.3	21.8	

CANADIAN NUCLEAR ASSOCIATION

SCENARIO 3: Low Growth

CANADIAN EMPLOYMENT - MANYEARS ('000)

DOMESTIC PROGRAM

	YEAR																						
	1980	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000	01	TOTAL
MANUFACTURING	4.9	4.6	3.7	3.6	3.5	4.1	4.1	3.2	2.8	2.8	2.7	2.5	2.6	3.0	3.1	4.0	4.4	4.7	4.6	4.4	4.3	3.0	80.7
CONSTRUCTION	3.7	3.7	3.2	2.9	2.5	3.0	3.1	2.8	2.3	2.4	2.3	1.6	1.7	2.4	2.4	2.7	3.2	3.6	3.6	3.1	3.4	2.7	62.4
ENGINEERING	1.9	1.7	1.5	1.5	1.1	1.0	1.4	1.3	0.8	1.1	1.1	1.0	0.6	1.2	1.4	1.9	1.3	2.0	1.6	1.0	0.9	0.6	27.9
HEAVY WATER	2.2	2.5	1.6	1.0	1.2	1.6	1.7	2.0	1.6	1.2	1.2	0.8	0.9	1.3	1.3	1.3	1.3	1.6	1.6	2.0	2.0	2.1	33.8
HALF FUEL CHARGE	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	1.7
DIRECT	12.9	12.7	10.1	9.1	8.2	9.7	10.3	9.4	7.5	7.6	7.4	6.0	5.9	8.0	8.2	9.9	10.3	12.0	11.4	10.6	10.7	8.6	206.6
INDIRECT	23.3	22.9	18.3	16.5	14.9	17.6	18.7	17.0	13.6	13.7	13.4	10.8	10.6	14.4	14.8	17.9	18.7	21.7	20.7	19.2	19.4	15.6	373.9
TOTAL	36.1	35.6	28.5	25.7	23.2	27.3	29.1	26.4	21.2	21.3	20.7	16.8	16.5	22.4	23.0	27.8	29.0	33.7	32.1	29.8	30.2	24.2	580.5

CANADIAN NUCLEAR ASSOCIATION

SCENARIO 3: Low Growth

CAPITAL EXPENDITURES ($'000,000)

EXPORT PROGRAM

	YEAR																					
	1980	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000	01	TOTAL
MAJOR EQUIPMENT	59	24	22	89	143	133	101	72	31	15	59	73	44	45	56	113	127	148	169	135	192	178	2018
BULK MATERIALS	32	13	10	52	92	81	55	39	17	7	27	46	34	26	29	55	77	89	104	86	95	104	1170
LABOUR	52	24	10	55	105	102	73	57	28	6	30	49	39	39	37	70	80	98	126	104	133	120	1437
ENGINEERING	19	10	20	50	66	57	37	28	19	19	27	31	20	22	36	59	72	68	73	70	80	86	969
HEAVY WATER	113	56	0	0	56	112	113	113	56	0	0	0	56	56	57	56	0	84	85	169	169	85	1436
HALF FUEL CHARGE	8	4	0	0	0	0	4	8	4	0	0	0	0	0	4	4	0	0	0	6	6	6	54
DISTRIBUTABLES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	283	131	62	246	462	485	383	317	155	47	143	199	193	188	219	357	356	487	557	570	665	579	7084
CANADIAN CONTENT	173	83	28	94	199	243	212	189	95	24	59	71	100	101	126	177	139	232	249	318	352	273	3537
% CANADIAN CONTENT	61	63	45	38	43	50	55	59	61	51	41	35	51	53	57	49	39	47	44	55	52	47	49
INSTALLED CAP. (1000 MW)	0.5	1.1	1.8	1.8	1.8	1.8	1.8	1.8	2.4	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.7	3.7	3.7	3.7	3.7	4.6	

CANADIAN NUCLEAR ASSOCIATION

SCENARIO 3: Low Growth

CANADIAN EMPLOYMENT - MANYEARS ('000)

EXPORT PROGRAM

	YEAR																						
	1980	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000	01	TOTAL
MANUFACTURING	0.4	0.2	0.2	0.7	1.1	1.0	0.8	0.5	0.2	0.1	0.4	0.5	0.3	0.3	0.4	0.8	1.0	1.1	1.3	1.0	1.3	1.3	15.2
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.2	0.1	0.2	0.5	0.7	0.6	0.4	0.3	0.2	0.2	0.3	0.3	0.2	0.2	0.4	0.6	0.8	0.7	0.8	0.8	0.9	1.0	10.7
HEAVY WATER	0.6	0.3	0.0	0.0	0.3	0.6	0.6	0.6	0.3	0.0	0.0	0.0	0.3	0.3	0.3	0.3	0.0	0.5	0.5	0.9	0.9	0.5	8.1
HALF FUEL CHARGE	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.5
DIRECT	1.4	0.6	0.4	1.2	2.1	2.3	1.9	1.6	0.8	0.3	0.7	0.9	0.9	0.9	1.2	1.8	1.8	2.3	2.5	2.8	3.2	2.8	34.4
INDIRECT	2.4	1.2	0.7	2.2	3.8	4.1	3.4	2.8	1.4	0.6	1.3	1.6	1.6	1.6	2.1	3.3	3.2	4.2	4.6	5.1	5.9	5.1	62.3
TOTAL	3.8	1.8	1.0	3.4	6.0	6.4	5.2	4.4	2.2	0.9	2.1	2.5	2.4	2.5	3.3	5.2	5.0	6.6	7.1	7.9	9.1	8.0	96.7

CANADIAN NUCLEAR ASSOCIATION

SCENARIO 3: Low Growth

CAPITAL EXPENDITURES ($'000,000)

COMBINED PROGRAM

	YEAR																						
	1980	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000	01	TOTAL
MAJOR EQUIPMENT	364	307	253	319	355	390	351	267	207	195	226	227	206	231	251	363	401	435	456	402	453	357	7015
BULK MATERIALS	213	177	143	180	219	225	208	161	112	106	123	135	128	136	139	195	233	262	270	247	247	223	4083
LABOUR	263	234	190	222	249	271	251	215	161	140	162	143	138	177	173	224	265	305	331	282	324	272	4993
ENGINEERING	158	137	130	157	144	132	137	122	74	97	110	104	65	107	134	198	168	212	186	144	147	132	2994
HEAVY WATER	497	506	288	186	265	399	408	471	339	208	206	151	208	282	283	283	227	366	367	528	528	462	7458
HALF FUEL CHARGE	24	23	11	4	0	0	9	19	15	15	10	0	5	11	10	9	11	11	6	15	21	22	251
DISTRIBUTABLES	503	483	348	284	250	341	361	342	330	296	255	176	225	273	271	290	354	364	396	403	453	343	7341
TOTAL	2022	1866	1363	1352	1482	1758	1725	1597	1238	1057	1092	936	975	1217	1261	1562	1659	1955	2012	2021	2173	1811	34134
CANADIAN CONTENT	1779	1753	1278	1147	1170	1458	1498	1423	1138	993	969	773	844	1087	1124	1324	1379	1634	1638	1707	1798	1462	29375
% CANADIAN CONTENT	87	93	93	84	78	82	86	89	91	93	88	82	86	89	89	84	83	83	81	84	82	80	86
INSTALLED CAP. (1000 MW)	5.9	6.5	9.1	10.9	12.2	12.2	12.8	13.5	15.0	16.5	17.4	18.9	18.9	18.9	19.8	20.6	21.3	22.1	23.0	23.9	23.9	26.4	

CANADIAN NUCLEAR ASSOCIATION

SCENARIO 3: Low Growth

CANADIAN EMPLOYMENT - MANYEARS ('000)

COMBINED PROGRAM

	YEAR																						
	1980	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000	01	TOTAL
MANUFACTURING	5.4	4.7	3.9	4.3	4.5	5.1	4.9	3.8	3.0	2.9	3.1	3.0	2.9	3.4	3.5	4.8	5.3	5.8	5.9	5.4	5.7	4.4	95.9
CONSTRUCTION	3.7	3.7	3.2	2.9	2.5	3.0	3.1	2.8	2.3	2.4	2.3	1.6	1.7	2.4	2.4	2.7	3.2	3.6	3.6	3.1	3.4	2.7	62.4
ENGINEERING	2.1	1.9	1.7	2.0	1.8	1.7	1.8	1.6	1.0	1.3	1.4	1.4	0.8	1.4	1.8	2.6	2.1	2.7	2.4	1.8	1.8	1.6	38.6
HEAVY WATER	2.8	2.8	1.6	1.0	1.5	2.2	2.3	2.6	1.9	1.2	1.2	0.8	1.2	1.6	1.6	1.6	1.3	2.1	2.1	3.0	3.0	2.6	41.9
HALF FUEL CHARGE	0.2	0.2	0.1	0.0	0.0	0.0	0.1	0.2	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	2.2
DIRECT	14.2	13.3	10.5	10.3	10.4	12.0	12.2	11.0	8.3	7.9	8.1	6.9	6.7	8.9	9.4	11.7	12.1	14.3	14.0	13.4	14.0	11.4	241.0
INDIRECT	25.7	24.1	19.0	18.7	18.8	21.7	22.1	19.9	15.1	14.3	14.7	12.5	12.2	16.0	16.9	21.2	21.9	26.0	25.3	24.3	25.3	20.7	436.2
TOTAL	39.9	37.4	29.5	29.0	29.1	33.7	34.3	30.8	23.4	22.1	22.8	19.3	18.9	24.9	26.3	33.0	34.0	40.3	39.2	37.7	39.2	32.1	677.2

APPENDIX 8

Present Commitments

CAPITAL Expenditures and Employment for Domestic Program

Export Program and Combined Program

CANADIAN NUCLEAR ASSOCIATION

Present Commitments

CAPITAL EXPENDITURES ($'000,000)

DOMESTIC PROGRAM

	YEAR																						
	1980	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000	01	TOTAL
MAJOR EQUIPMENT	305	283	231	227	197	198	158	113	75	38	20	0	0	0	0	0	0	0	0	0	0	0	1844
BULK MATERIALS	181	164	133	126	120	117	97	68	40	20	6	0	0	0	0	0	0	0	0	0	0	0	1073
LABOUR	211	210	180	165	138	139	117	97	67	45	27	0	0	0	0	0	0	0	0	0	0	0	1397
ENGINEERING	139	127	110	100	59	48	35	28	19	13	8	0	0	0	0	0	0	0	0	0	0	0	685
HEAVY WATER	384	450	288	186	209	287	295	302	227	151	75	0	0	0	0	0	0	0	0	0	0	0	2654
HALF FUEL CHARGE	16	19	11	4	0	0	5	11	11	11	6	0	0	0	0	0	0	0	0	0	0	0	94
DISTRIBUTABLES	503	483	348	271	228	306	298	249	197	128	59	0	0	0	0	0	0	0	0	0	0	0	3070
TOTAL	1739	1735	1301	1079	951	1095	1005	868	636	406	201	0	0	0	0	0	0	0	0	0	0	0	11016
CANADIAN CONTENT	1606	1670	1250	1027	905	1051	969	842	619	397	197	0	0	0	0	0	0	0	0	0	0	0	10532
% CANADIAN CONTENT	92	96	96	95	95	95	96	97	97	97	98	0	0	0	0	0	0	0	0	0	0	0	95
INSTALLED CAP. (1000 MW)	5.4	5.4	7.3	9.2	10.4	10.4	11.1	11.7	12.6	13.5	14.3	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	

CANADIAN NUCLEAR ASSOCIATION

Present Commitments

CANADIAN EMPLOYMENT - MANYEARS ('000)

DOMESTIC PROGRAM

	YEAR																						
	1980	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000	01	TOTAL
MANUFACTURING	4.9	4.6	3.7	3.6	3.2	3.2	2.6	1.9	1.2	0.6	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.8
CONSTRUCTION	3.7	3.7	3.2	2.9	2.4	2.4	2.1	1.7	1.2	0.8	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.5
ENGINEERING	1.9	1.7	1.5	1.4	1.2	0.7	0.5	0.4	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.5
HEAVY WATER	2.2	2.5	1.6	1.0	1.2	1.6	1.7	1.7	1.3	0.8	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.0
HALF FUEL CHARGE	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
DIRECT	12.9	12.7	10.1	9.0	7.6	8.0	6.8	5.7	4.0	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	80.6
INDIRECT	23.3	22.9	18.3	16.2	13.8	14.4	12.4	10.4	7.2	4.5	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	145.9
TOTAL	36.1	35.6	28.5	25.2	21.5	22.3	19.2	16.1	11.2	7.0	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	226.4

CANADIAN NUCLEAR ASSOCIATION

Present Commitments

CAPITAL EXPENDITURES ($'000,000)

EXPORT PROGRAM

	YEAR																					
	1980	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000	01	TOTAL
MAJOR EQUIPMENT	59	24	22	89	143	133	101	72	28	0	0	0	0	0	0	0	0	0	0	0	0	0	671
BULK MATERIALS	32	13	10	52	92	81	55	39	15	0	0	0	0	0	0	0	0	0	0	0	0	0	389
LABOUR	52	24	10	55	105	102	73	57	26	0	0	0	0	0	0	0	0	0	0	0	0	0	504
ENGINEERING	19	10	20	50	46	57	37	28	12	0	0	0	0	0	0	0	0	0	0	0	0	0	299
HEAVY WATER	113	56	0	0	56	112	113	113	56	0	0	0	0	0	0	0	0	0	0	0	0	0	619
HALF FUEL CHARGE	8	4	0	0	0	0	4	8	4	0	0	0	0	0	0	0	0	0	0	0	0	0	28
DISTRIBUTABLES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	283	131	62	246	462	485	383	317	141	0	0	0	0	0	0	0	0	0	0	0	0	0	2510
CANADIAN CONTENT	173	83	28	94	199	243	212	189	87	0	0	0	0	0	0	0	0	0	0	0	0	0	1308
% CANADIAN CONTENT	61	63	45	38	43	50	55	59	61	0	0	0	0	0	0	0	0	0	0	0	0	0	52
INSTALLED CAP. (1000 MW)	0.5	1.1	1.8	1.8	1.8	1.8	1.8	1.8	2.4	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	

CANADIAN NUCLEAR ASSOCIATION

Present Commitments

CANADIAN EMPLOYMENT - MANYEARS ('000)

EXPORT PROGRAM

	YEAR																					
	1980	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000	01	TOTAL
MANUFACTURING	0.4	0.2	0.2	0.7	1.1	1.0	0.8	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.2	0.1	0.2	0.5	0.7	0.6	0.4	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3
HEAVY WATER	0.6	0.3	0.0	0.0	0.3	0.6	0.6	0.6	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.5
HALF FUEL CHARGE	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
DIRECT	1.4	0.6	0.4	1.2	2.1	2.3	1.9	1.6	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.1
INDIRECT	2.4	1.2	0.7	2.2	3.8	4.1	3.4	2.8	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.8
TOTAL	3.8	1.8	1.0	3.4	6.0	6.4	5.2	4.4	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.9

CANADIAN NUCLEAR ASSOCIATION

Present Commitments

CAPITAL EXPENDITURES ($'000,000)

COMBINED PROGRAM

	YEAR																						
	1980	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000	01	TOTAL
MAJOR EQUIPMENT	344	307	253	316	340	331	259	185	103	38	20	0	0	0	0	0	0	0	0	0	0	0	2515
BULK MATERIALS	213	177	143	178	212	198	152	107	55	20	6	0	0	0	0	0	0	0	0	0	0	0	1462
LABOUR	263	234	190	220	243	241	190	154	93	45	27	0	0	0	0	0	0	0	0	0	0	0	1901
ENGINEERING	158	137	130	150	125	105	72	56	31	13	8	0	0	0	0	0	0	0	0	0	0	0	984
HEAVY WATER	497	506	288	186	265	399	408	415	283	151	75	0	0	0	0	0	0	0	0	0	0	0	3473
HALF FUEL CHARGE	24	23	11	4	0	0	9	19	15	11	6	0	0	0	0	0	0	0	0	0	0	0	122
DISTRIBUTABLES	503	483	348	271	228	306	298	249	197	128	59	0	0	0	0	0	0	0	0	0	0	0	3070
TOTAL	2022	1866	1363	1325	1413	1580	1388	1185	777	406	201	0	0	0	0	0	0	0	0	0	0	0	13526
CANADIAN CONTENT	1779	1753	1278	1121	1104	1294	1181	1031	706	397	197	0	0	0	0	0	0	0	0	0	0	0	11840
% CANADIAN CONTENT	87	93	93	84	78	81	85	87	90	97	98	0	0	0	0	0	0	0	0	0	0	0	87
INSTALLED CAP. (1000 MW)	5.9	6.5	9.1	10.9	12.2	12.2	12.8	13.5	15.0	16.5	17.4	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	

CANADIAN NUCLEAR ASSOCIATION

Present Commitments

CANADIAN EMPLOYMENT - MANYEARS ('000)

COMBINED PROGRAM

	YEAR																						
	1980	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000	01	TOTAL
MANUFACTURING	5.4	4.7	3.9	4.3	4.3	4.2	3.4	2.4	1.4	0.6	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	34.8
CONSTRUCTION	3.7	3.7	3.2	2.9	2.4	2.4	2.1	1.7	1.2	0.8	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.5
ENGINEERING	2.1	1.9	1.7	1.9	1.5	1.3	0.9	0.7	0.4	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.8
HEAVY WATER	2.8	2.8	1.6	1.0	1.5	2.2	2.3	2.3	1.6	0.8	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.5
HALF FUEL CHARGE	0.2	0.2	0.1	0.0	0.0	0.0	0.1	0.2	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
DIRECT	14.2	13.3	10.5	10.1	9.8	10.2	8.7	7.3	4.7	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	92.6
INDIRECT	25.7	24.1	19.0	18.4	17.7	18.5	15.8	13.2	8.4	4.5	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	167.7
TOTAL	39.9	37.4	29.5	28.5	27.4	28.7	24.5	20.5	13.1	7.0	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	260.3

REPORT #3

OVERVIEW OF NUCLEAR INDUSTRY IN CANADA

TOUCHING ON

- RESEARCH AND DEVELOPMENT
- NUCLEAR FUEL MANUFACTURING
- RADIONUCLIDES FOR INDUSTRY AND MEDICINE
- OPERATION AND MAINTENANCE OF CANDU ELECTRIC GENERATING STATIONS AND HEAVY WATER PLANTS
- REGULATORY AGENCIES

ECONOMIC DEVELOPMENT COMMITTEE

March 1982

INTRODUCTION

This is the third report prepared by the Economic Development Committee to provide the CNA with current economic data on Canada's nuclear industry. The areas which will be covered in this report are

- Research and Development
- Nuclear Fuel Manufacturing
- Radionuclides for Industry and Medicine
- Operation and Maintenance of CANDU Electric Generating Stations and Heavy Water Plants
- Regulatory Agencies

RESEARCH AND DEVELOPMENT

AECL Research Company, performs and/or funds most of the nuclear research and development which is carried out in Canada. Other organizations which conduct or fund research and development are Ontario Hydro, Atomic Energy Control Board (AECB), Eldorado Nuclear Limited, TRIUMF, Institut de recherche d'Hydro-Quebec (IREQ), and some companies in the private sector. A high proportion of research and development is funded by grants from the Government of Canada.

The field of research is very broad, including basic research such as the development of a new technique for predicting the chemical fate of radioactive iodine, the radioisotope potentially of most concern in a reactor accident, the research program to assure the safe and permanent disposal of irradiated CANDU fuel waste, applied research and development aimed at even greater safety and reliability of CANDU reactor systems and research on future energy supplies. The AECB funds research directed at the impact of all aspects of the nuclear fuel cycle and materials on man including health effects, environmental processes, and risk and safety evaluation. In addition research is proceeding on the safeguards program and on radiation protection. Among its research programs Eldorado Nuclear Limited carried out research aimed at reducing uranium losses at the mine and mill, removal of radium from satellite mine water, and assisting the commissioning and expansion programs at the refineries.

The AECL 1978-79 Annual Report showed 3069 employees in its Research Company. This would have increased by not more than 200 persons by the end of 1980. It is estimated that all other organizations may have something less than 200 persons involved in Research and Development.

In 1980 expenditures on Nuclear Research and Development were $141 million for AECL[1] and approximately $20 million for other organizations.

NUCLEAR FUEL MANUFACTURING

There are three manufacturers of CANDU fuel bundles in Canada. In a report "Estimating the Costs of AECB Regulation" by SECOR Inc. issued in April 1981 [2] the following statistical information was provided.

TABLE 1

OUTPUT AND EMPLOYMENT IN THE CANADIAN NUCLEAR FUEL FABRICATION INDUSTRY IN 1980

Producer	Metric Tons of Uranium Processed*
Westinghouse Canada Inc. Port Hope, Ontario	615
Canadian General Electric Co. Ltd. Toronto and Peterborough, Ontario	420
Combustion Engineering-Superheater Ltd. Moncton, New Brunswick	65
Total	1,100
Total Personnel	649

* - Estimated where necessary

The basic manufacturing process which is common to all three of the nuclear fabricators is relatively simple in comparison, for example, with petrochemicals. As a reflection of this, it is not very capital intensive, with an estimated fixed capital investment of only $61,000/worker. It is a physical transformation process, yielding precisely-sized fuel pellets from ceramic grade UO_2 powder. This fuel is then assembled into bundles which are fabricated from zircaloy tube, bar and sheet.

TABLE 2

THE INDUSTRY COST STRUCTURE

	$(000)
o 1980 Operating Costs*	
Raw Materials	23,300
Manufacturing Operations	16,900
Depreciation	4,000
General and Administration	3,300
Marketing	500
Total	48,000
o Capital Investment 1980$	
Total	39,500

* Exclusive of uranium, interest, taxes and profits. Uranium which is the property of the utility would cost $130,000,000 @ $118/Kg.

Because most foreign customers for CANDU generating stations say they are going to make their own nuclear fuel, the CANDU fuel bundle market will grow in proportion to the CANDU generating stations which will be constructed and operated in Canada. The market for stations which are operating and under construction will be approximately 2100 metric tons of processed uranium in 1990 as compared with 1100 metric tons in 1980.

RADIONUCLIDES FOR INDUSTRY AND MEDICINE

As in research and development, AECL is the major force in this field in Canada from the point of view of manufacturing and employment. This activity is carried out by the AECL Radiochemical Company. Information on its activities is provided in the AECL Annual Reports. The AECL Annual Report for 1980-81 reported that

- the Company serves a world-wide market
- the order backlog is the highest in the Company's history
- the Medical Group, which provides a complete range of high technology products for the radiation treatment of cancer, received the first orders for the Company's new Therac 25 medical accelerator, a Canadian developed unit
- the Industrial Group had a 56% increase in orders received for gamma irradiators and for Cobalt 60 produced by Ontario Hydro
- the Isotope Group produces and markets a wide range of isotopes for use in medical diagnosis. Orders received increased 90 per cent over 1979-80. The group is the major supplier of bulk isotopes in the world.

Sales in the last three years were 1978-79 - $37.4 millions,[6] 1979-80 - $48.8 millions, 1980-81 - $55.2 millions. Employment was 699 in 1978-79[6] and has grown about 20% since then.

CANDU ELECTRIC GENERATING STATIONS

Ontario Hydro had the only operating CANDU electric generating stations in Canada in 1980. They were NPD, Douglas Point, Pickering A with 4 units of 515 MWe and Bruce A with 4 units of 740 MWe. In 1980, these stations produced 35,579 million kW.h of electricity, 34 percent of Ontario Hydro's total production.[3] Based on capacity factors and total unit energy costs which have been reported for Pickering A and Bruce A for 1980,[7] the cost of generating this electricity was approximately $520 million, less than 22 percent of Ontario Hydro's total 1980 costs.[3] It is significant that the Pickering Unit 3 and Bruce Units, 1,2 and 3 were the four top performing power reactors rated at over 500 MWe in the world in 1980. Furthermore the four Pickering units and two of the Bruce units were in the top ten for lifetime capacity factor for world power reactors rated at over 500 MWe.

The actual employment at the operating CANDU stations is not publicly reported. However employment for operating and maintaining CANDU stations will increase significantly as the fourteen reactors which are under construction in Canada are brought into service. The in-service year for the last of these, Darlington Unit 4, is 1990.

HEAVY WATER PLANTS

In 1980 three heavy water plants, Glace Bay and Port Hawkesbury owned by AECL Chemical Company and Bruce A owned by Ontario Hydro, produced 1192 Mg of Heavy Water. In addition Bruce B was commissioned and produced 30 Mg.[4] The value of the heavy water produced by AECL was reported as $120.2 millions in the 1980-81 report. Employment in the AECL Chemical Company was approximately 800 employees.[6] Employment in Ontario Hydro Heavy Water plants is included in the employment for the total Bruce Complex and is not readily available.

Heavy Water will be required for the eighteen CANDU stations under construction, four of which are outside Canada. The continuation of this business is dependent on the committing of more stations subsequent to Darlington and Romania Units 1 and 2.

REGULATORY AGENCIES

The Atomic Energy Control Board is the major regulatory agency for the nuclear industry in Canada. Other federal government departments and ministries of provincial governments also have a regulatory impact on the industry. However, their work is generally directed at protection of the environment, at safety and health, and at working conditions for mining and industrial activities rather than being specifically directed at the nuclear industry.

Information on the AECB is provided in its annual reports. In the 1980-81 Annual Report the following items were reported.

- there were 190 persons on staff
- there were 76 employees of various provincial ministries and departments who acted as inspectors for the Board to monitor compliance with the conditions set out in licenses and with the requirements of regulations

- research of $1.8 millions was funded in conjunction with AECL in support of IAEA programs
- research of $0.7 millions was funded on risk and safety evaluation
- the expenditures for the AECB for the 1980-81 year were $14 millions.

The activities of the Board include legislative and legal matters, regulation of nuclear facilities, regulation of nuclear materials including transportation and disposal of those materials, compliance monitoring, regulatory research and developments, safeguards and security control of prescribed substances and equipment, international activities, radioactivity investigation and clean-up and communications with the public.

CONCLUSION

The foregoing has been an overview of those parts of the Canadian Nuclear Industry not covered in earlier reports. It would appear that business activity in the radionuclide industry, the operation and maintenance of CANDU electric generating stations and the regulatory process will grow. On the other hand research and development is dependent on grants from the Government of Canada and heavy water production will be needed only if CANDU power reactors are committed after Darlington and Romania.

References:-

1. Atomic Energy of Canada Limited Annual Report 1980-81

2. "Estimating the Costs of AECB Regulation" - SECOR Inc., April 1981

3. Ontario Hydro Annual Report 1980

4. Nuclear Canada Yearbook 1981

5. Atomic Energy Control Board Annual Report 1980-81

6. Atomic Energy of Canada Limited Annual Report 1978-79

7. McConnell, L.G. and Woodhead, L.W. "Economics of CANDU' February 16, 1981

POOR

QUALITY

ORIGINAL